Proceedings

of the

Philosophical Society

of Glasgow.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY

OF GLASGOW.

VOL. XX.

1888-89.

EDITED BY THE SECRETARY.

PUBLISHED FOR THE SOCIETY BY

JOHN SMITH AND SON,

129 WEST GEORGE STREET, GLASGOW.

1889.

Vol.	IX. (No. 1),	Price 2s. 6d.
Do.	IX. (No. 2),	,, 3s. 6d.
Do.	X. (No. 1),	,, 3s. 6d.
Do.	X. (No. 2),	,, 3s. 9d.
Do.	XI. (No. 1),	,, 4s. 0d.
Do.	XI. (No. 2),	,, 4s. 6d.
Do.	XII.,	,, 4s. 6d.
Do.	XIII. (No. 1),	,, 4s. 6d.
Do.	XIII. (No. 2),	,, 4s. 6d.
Do.	XIV.,	,, 10s. 6d.
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Do.	XVI.,	,, 10s. 6d.
Do.	XVII.,	,, 10s. 6d.
Do.	XVIII.,	,, 10s. 6d.
Do.	XIX.,	,, 10s. 6d.
Do.	XX.,	,, 10s. 6d.

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PLATES.

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

EIGHTY-SIXTH SESSION.

PRESIDENT'S ADDRESS.

I.—*On the "Ticketed Houses" of Glasgow, with an Interrogation of the Facts for Guidance towards the Amelioration of the Lives of their Occupants.* By JAMES B. RUSSELL, B.A., M.D., LL.D., President of the Society.

[Read before the Society, 7th November, 1888.]

WE open our new session under circumstances of peculiar sadness. It is only a few weeks since a distinguished member of this Society was removed from among us in the very heyday of his reputation. To-morrow some of us will follow to the grave the remains of a former occupant of this chair, equally distinguished in his own sphere. Both were friends of mine; and I shall only, on the present occasion, endeavour to express what I find in my own mind as the impression left by their contact with me, leaving to other and more competent hands the summing-up of what they were to the Society and to the professions which they adorned.

I had abundant opportunity of forming some estimate of Mr. Sellars as an architect, through occasions arising from my official position. I assisted Mr. Carrick in adjudicating upon the competitive plans sent in for the Victoria Infirmary. As a director of the Sick Children's Hospital and Dispensary, and of Anderson's College Medical School, I made further acquaintance with his work. The outcome of these experiences was to convince me that Mr. Sellars had a singular grasp of the hygienic and administrative requirements of such institutions, and a wonderful facility in giving them satisfactory structural expression. The originality and boldness with which he encountered difficulties, such, for example, as a refractory site in relation to the functions to be performed in his building, bore all the marks of true genius. He seemed never to be trammelled by precedent or to exhaust his fertility of resource. Along with this eminently practical faculty there was a graceful and fastidious taste, which softened all his effects with a refined detail of artistic decoration. I shall not refer to his crowning work—the International Exhibition—excepting to remark upon the singularity of the fortune which led Mr. Sellars to expend the ripeness of his imagination, and exhaust his energies, upon a structure of so much beauty and delight which was yet to serve only a passing purpose. Usually between the transitory life of the architect and the duration of his works there is contrast and not similarity; but here the work passes away with its author, and both alike will remain to us only as a memory or a picture.

With Dr. William Wallace my intimacy was naturally, owing to our relative positions in the public service, much greater and of longer duration than with Mr. Sellars. In 1876, and again in 1879, we were together as members of deputations of the Town Council, visiting sewage works all over England, and in 1880 we travelled alone on the same errand. We were thus for weeks together in continuous friendly and professional intercourse. I may say that the reports of these deputations are practically the work of Dr. Wallace, and there is no part of the enormous literature of the sewage question which has more intrinsic value or is better known. The reason is not far to seek. These reports are remarkable for dealing with a subject which is ravaged by faddists, quacks, and speculators, in a dispassionate, plainly-practical, and common-sense way. This seemed to me to be Dr. Wallace's forte. He applied his knowledge of chemical science to practical purposes, whether industrial, or sanitary, or commercial, with a breadth of view which showed how profound was his knowledge of applied chemistry, how intimate his acquaintance with industrial processes, and how, over all, there presided a sound and clear judgment. In questions of trade nuisances authorities could have no more trustworthy referee, and clients no more honest and skilful adviser. As a man Dr. Wallace was singularly unaffected in manner, equable in temper, and quietly genial and kindly in disposition. At the grave's mouth it is not qualities of intellect which come uppermost in our thoughts, but those of the heart, and I can say of our departed friend that all his relationships were sweetened by the gentleness of his heart.

But, gentlemen, although its members die, the Philosophical Society lives, and I now propose to tell you something about the "ticketed houses" of Glasgow, and to interrogate the facts for guidance towards the amelioration of the lives of their occupants.

The general relation between the size of the houses in which people live and the health they enjoy has been sufficiently established. Comparing the eight principal towns of Scotland on the basis of their death-rate in the ten years, 1871-80, I have elsewhere shown that they fall "into two well-marked sets of four, viz.:—Aberdeen, Leith, Perth, and Edinburgh, with death-rates below 24, and houses of three to five rooms; and Dundee, Greenock, Paisley, and Glasgow, with death-rates above 25, and houses below three rooms. In this group the death-rate rises *pari passu* with the diminution in size of the average house." Further, following the average number of inmates per inhabited room, it was found that in general the mortality rose step by step with that number in these towns, and, still further, that if we began with Aberdeen, which has 13·6 per cent. of its inhabitants living in one room and the lowest death-rate, we rose gradually, without a break, to Glasgow, with 24·7 per cent. living in one room and the highest death-rate. Again, comparing the twenty-four districts into which Glasgow is divided for statistical purposes, there also the same general relation was demonstrated. "Blythswood" stood at the top, with the lowest death-rate and the largest and most thinly-peopled houses; while "Bridgegate and Wynds" stood at the bottom, with the highest death-rate and the smallest and most crowded houses. In all these investigations I could only be said to work round the question—using such data as were available—arriving at results which were sound and unimpeachable, but still indirect.

In 1877, in a paper "On the Comparative Prevalence of Filth Diseases in Town and Country," which I read to this Society, I said—"I believe that if you were to classify the whole population of the city according as they occupied houses of one, two, three, four, five, or more apartments, and then to ascertain the aggregate death-rate from all causes in each class . . . it would have its maximum in the population living in one-apartment houses, and fall in gradations to a minimum among those who inhabited the largest houses." In that paper I submitted the death-rates among the inhabitants thus classified from diphtheria, croup, enteric fever, and diarrhœa, calculated for three and a-half years. At that time no similar investigation had been made. The nearest was a classification of the inhabitants of Barmen according to income, which brought out a mortality of 34½ per 1,000 among persons having an income of less than £30; of 19 among persons whose income was from £30 to £75; of 18 among persons whose income was from £75 to £150; and of 16½ above £150. Recently the Medical Officer of Dundee has constructed a table of the mortality statistics of that town for 1884, which shows that the death-rate of the inhabitants of houses of one and two rooms was 23·3; of three-room houses, 17·2; of four-room houses and upwards, 12·3—while the general death-rate of Dundee was 20·7. This year, in Edinburgh, an investigation of the death-rate on the basis of rental has been commenced. The results for the first half of the year are as follow:—Under £5, death-rate per 1,000 inhabitants, 23; £5 and under £10, 21·34; £10 and under £15, 20·1; £15 and under £20, 15·86; £20 and under £30, 14·1; £30 and under £40, 18·8; £40 and under £50, 13·16; £50 and upwards, 14·76—the general death-rate for the same period being 19. It is premature to draw inferences from these data; but the basis of rental is not so good as that of size of house. Whatever hygienic meaning more extended statistics on this basis may possess must depend upon the relation of rental to the air-space or house-room which it represents, and, therefore, it would be better at once to take the house-room as the basis.

Before submitting the results of an investigation of the mortality statistics of the inhabitants of Glasgow for 1885, according to the size of the houses which they occupied, let me say a word on the difficulties of such investigations. It is necessary that the residence of every deceased person shall be sought out and its size noted. If every address led the inquirer to a front door this would be an easy task; but when he finds himself at a close whose number serves for a front land and several back lands, with no end of turnpikes, stairs, flats, and lobbies, the task is anything but easy. The address then becomes something like this: Bridgegate, No. 29, back land, stair 1st left, 3 up, right lobby, door facing! But the description of Nineveh is true of Glasgow :—"That great city wherein are more than six score thousand persons that cannot discern between their right hand and their left hand." Mistakes in the addresses given are very frequent. You may find yourself at the door of a shop, or there may be no such number in the street, or no such person discoverable at the number given. In short, from a variety of causes, between 2 and 3 per cent. of the deaths registered cannot be traced, and their allocation therefore remains "unknown." Then there are the deaths in Institutions. These are traced as far as possible, but a large number, amounting to between 3 and 4 per cent. of the deaths in the city, cannot be so allocated: and if they represent Glasgow people they simply remain against the Institution. It is obvious that all those deaths of persons whose residence cannot be traced, whether they take place at their own houses or in Institutions, belong to the class of dwellers in small houses, and that we cannot simply set them aside if we wish to get a fair statement of the facts. This is the great difficulty of the inquiry. Our poorhouses in particular are filled with persons from our one- and two-room houses. They die there of pulmonary and other diseases, which reflect back whatever hygienic meaning they possess upon the locality where they lived. Yet they frequently cannot be referred to any special house. I shall subsequently explain how I propose to get over this difficulty. Having distributed the deaths, the next question is—What is the population of the various grades of house? This I have got by assuming that the proportion was the same in 1885 as in 1881, which I believe to be sufficiently correct in dealing with the city as a whole.

The results of this inquiry, when tabulated, assume very insignificant dimensions considering the time and trouble they represent, but statistical tables of any sort cannot profitably be submitted in speech, and I shall endeavour to put you in possession of their outcome as plainly and briefly as possible. The population of Glasgow in 1885 was 543,295, the number of deaths was 13,439. The distribution of population and the deaths in the inhabited houses according to their size is as follows :—

	Population.	Deaths.
1 Room, - - -	134,728	3,636
2 Rooms, - - -	243,691	6,325
3 do., - - -	86,956	1,747
4 do., - - -	32,742	581
5 do. and upwards, -	38,647	434
Institutions, - - -	6,531	427
Untraced, - - -	—	289
Whole City, -	543,295	13,439

Let us first consider the proportion of the total population who lived, as contrasted with the proportion of the total deaths which took place, in each size of house. The result is shown in the following table :—

	Population.	Deaths.
1 Room, -	24·7 per cent.	27 per cent., or 2·3 per cent. *above* due proportion.
2 Rooms, -	44·7 ,,	47 ,, 2·3 ,, ,,
3 do., -	16 ,,	13 ,, 3 per cent. *below* due proportion.
4 do., -	6·1 ,,	4·3 ,, 1·8 ,, ,,
5 do. and upwards,	7·1 ,,	3·3 ,, 3·8 ,, ,,
Institutions, -	1·4 ,,	3·2 ,,
Untraced, -	—	2·2 ,,

I have constructed two diagrams which will convey to your eyes the general meaning of this mass of figures, which is the excessive incidence of the mortality of the city upon the inhabitants of houses of one and two rooms. The inmates of our institutions are placed along with the inhabitants of one- and two-room houses in the Population diagram, and the institutional and untraced deaths alongside the deaths contributed by one- and two-room houses in the Mortality diagram. The result is that those houses

Population.

Deaths.

contained 70·8 per cent. of the population, and contributed 79·4 per cent. of the deaths, or 8·6 per cent. more than their due proportion; while the remaining 29·2 per cent. of the population, living in houses of three rooms and upwards, contributed only 20·6 per cent. of the deaths, or 8·6 per cent. less than their due proportion.

Let us next compare the death-rates in these various classes of the population. Leaving out of consideration the deaths which could not be allocated, I find—giving the calculations in round numbers per 1000 of the population—that, while the general death-rate of the city in 1885 was 25, the death-rate in one-room houses was 27; in two-room houses 26; in three-room houses 20; in four-room houses 18; in houses of five rooms and upwards only 11. But this leaves 716 unallocated deaths unaccounted for. I have therefore divided the population into three classes, namely—(1) Those living in one and two rooms, with which I include the inmates of Institutions and those unallocated deaths; (2) those living in houses of three and four rooms; and (3) those living in houses of five rooms and upwards. The death-rate in the first class is then found to be 27·74 per 1000, in the second 19·45, and in the third only 11·23.

We now turn to the question—What is the comparative incidence of certain classes of disease upon these classes of the population? I take zymotic or infectious diseases; diseases of the lungs, including consumption; diseases special to children under five years of age, such as convulsions and other affections of the brain and nervous system, atrophy or wasting, and premature birth, which are all essentially connected with disordered or defective nutrition; and I have also selected deaths in children from accident and syphilitic disease, a small class, but one pregnant with meaning.* The results are exhibited in another diagram (see page 9), the height of the columns in which, being on the same scale, will convey to your eyes both the comparative aggregate death-rate in the three grades of houses, and the comparative prevalence among their inhabitants of these classes of disease. The rates are per 100,000 inhabitants, thus converting the decimals in rates per 1000 into whole numbers:—

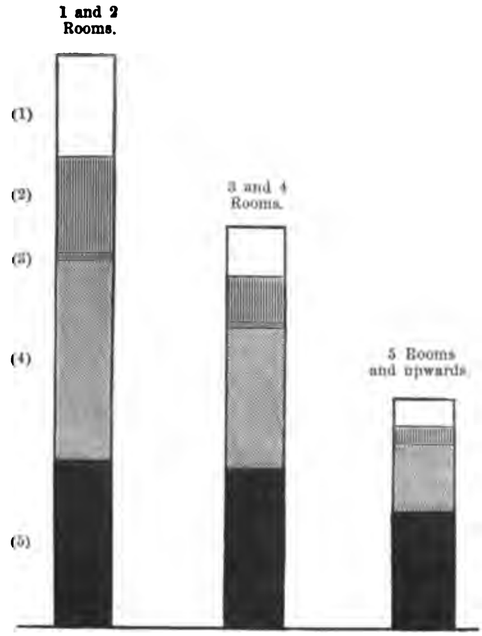
	1 and 2 Rooms.	3 and 4 Rooms.	5 Rooms and upwards.
Zymotic Diseases (including Diarrhœa),	478	246	114
Acute Diseases of the Lungs (including Consumption), - -	985	689	328
Nervous Diseases and Diseases of Nutrition of Children, - -	480	235	91
Accidents and Syphilis in Children, -	32	11	—
Miscellaneous Unclassified Diseases, -	799	764	590
All Causes, - - - -	2,774	1,945	1,123

The general result may be summed up with sufficient accuracy in these numerical expressions. Taking the death-rates in the largest houses as unity, the death-rate from *zymotic diseases* was 2 in medium-sized houses and 4 in the smallest houses; the death-rate from *diseases of the lungs* was 2 in medium-sized houses and 3 in the smallest houses; and from *diseases of nutrition special to children* it was 2½ in medium-sized houses and fully 5 in the smallest houses. There were no deaths from *accident*

* The following Table gives the actual numbers from which the death-rates are calculated:—

Size of House.	Zymotic.	Lungs.	Children.	Accidents, &c.	Others.	Total.
1 Room, - - - -	666	1,324	657	63	926	3,636
2 Rooms, - - -	1,118	2,244	1,138	51	1,774	6,325
3 do., - - - -	228	637	222	10	650	1,747
4 do., - - - -	67	188	59	3	264	581
5 do. and upwards, -	44	127	35	—	228	434
Institutions, - -	32	132	24	5	234	427
Untraced, - - -	24	90	30	2	143	289
Whole City, -	2,179	4,742	2,165	134	4,219	13,439

or specific disease in the large houses; but, taking the death-rate in the medium-sized houses as unity, the death-rate from these causes in the smallest houses was 3. A flood of light is thrown



(1) Zymotic Diseases. (2) Nervous and other Diseases special to Children. (3) Accidents and Syphilis in Children. (4) Diseases of the Lungs. (5) Miscellaneous.

upon these facts by a paper which appeared in the *Transactions* of the Royal Society of London for 1887, on "The Carbonic Acid, Organic Matter, and Micro-Organisms in Air, more especially of Dwellings and Schools," by Professor Carnelley and Drs. Haldane and Anderson. We might safely interpret our figures on general principles as well as from the observations made by the senses of those who are familiar with the comparative cubic space and the prevalent atmospheric conditions of a large proportion of our small houses, that the prevalence of zymotic and pulmonary diseases was causally connected therewith; but precise scientific observation and ascertainment of physical facts are always welcome, and these we have in this paper. "Taking the average quantity (in excess of outside air) of carbonic acid, organic matter, and micro-organisms, respectively, in houses of four or more rooms as unity, then in one- and two-roomed houses" the following table shows the results of chemical analysis and the application of Hesse's method of determining the number and nature of the micro-organisms present in the air, in the case of selected houses in Dundee:—

	Houses of 4 Rooms and upwards.	2-Roomed Houses.	1-Roomed Houses.
Cubic space per person,	1	0·13	0·11
Carbonic acid,	1	1·5	2·0
Organic matter,	1	1·6	4·4
Micro-organisms, total,	1	5·1	6·7
Bacteria,	1	5·1	6·9
Moulds,	1	5·5	3·0

Dr. Anderson contributes an elaborate "Comparison of the Mortality Statistics with the Composition of the Air of Dwelling-houses," perhaps more elaborate in respect of the classification of disease in minute detail than the smallness of the figures when so subdivided warrants, but his main conclusions agree in general with mine. He finds "that the rapid increase in the death-rate as we pass from four- to one-roomed houses is by far most marked in children under 5;" and that acute diseases of the lungs, and zymotic diseases in general, are also in excess.

Although I have classed consumption with other affections of the lungs, because of dubiety about the diagnosis in the case of people who receive so little medical attention as our Glasgow poor, as shown by the number of uncertified deaths, it is interesting to note that the death-rate from consumption is highest among the inmates of three-room houses in Glasgow, as it is in Dundee. Dr. Anderson's suggested explanation is probably correct, that the high infant mortality from other forms of tubercular disease returned as nervous diseases, atrophy, wasting, &c., prevents the growth of young adults in the smaller houses, these being most prone to the incidence of tubercle on the lungs.

Let me recall to you the fact that the mean death-rate was 27·74, 19·45, and 11·23 in the inhabitants of the three grades of houses. Now it is quite clear that if the whole city is divided into twenty-four districts, in which these three classes of inhabitants are mingled in different proportions, and we find that these districts produce death-rates ranging from 16 to 42, there must be vast differences in the range of mortality even in the same grade of houses. If houses of one and two apartments, of three and four apartments, and of five apartments and upwards were homogeneous in their vital results we might account for death-rates below 28, but not for those above. It must be apparent, from the fact that 70 per cent. of the population live in the one- and two-room houses, and only 7 per cent. in the largest houses, that the secret of the health of Glasgow lies within the one- and two-room houses. That there are enormous differences in the vital results of the one- and two-room houses must be admitted when we find districts which have practically the same proportion of these houses returning death-rates separated by such a wide interval as 23 and 42. These were the death-rates in 1885 of the district of "St. Rollox," so called because it touches the works of that name on their southern border, and of "Bridgegate and Wynds." In the former 83 per cent., in the latter 84 per cent. of the houses are one- and two-roomed. The former had a mortality of 23, the latter of 42. What circumstances have fixed this great gulf between the inhabitants of the small houses of St. Rollox and of Bridgegate and Wynds? Is it a difference in the houses, or a difference in the people, or both?

I find in a "Report on the Operations of the Sanitary Department of Glasgow, for the year ending 31st December, 1887," data collected with great intelligence and labour by Mr. Fyfe, Sanitary Inspector, among which, supplemented from MS. records of the department, there is material which will help us to a solution of this problem. It is better to retire to one's study with this unpretentious pamphlet than with Karl Marx or Henry George. I may remind you that the Glasgow Police Act confers a discretionary power to regulate the occupation of houses of not more than three rooms, and not exceeding an aggregate capacity of 2,000 cubic feet, exclusive of lobbies and recesses. This is done by affixing tinplate tickets on the outer door, stating the cubic contents, and the proportionate inmates allowed, at the very low rate of 300 cubic feet per adult or two children under eight years. These are called "ticketed houses" and are all one- or two-apartment houses. A system of night-inspection over such houses is constantly maintained, and results in prosecution for overcrowding when the legal number is exceeded. It was under the guidance of Typhus Fever that this system was originally applied, and its extension still follows the discoveries of the epidemic inspector. But, as you may suppose, the better class of tenants avoid such houses and even their neighbourhood. Consequently, landlords are always warned before tickets are put up in fresh localities, so that they may save the reputation of their property by getting rid of the overcrowding tenant. You will readily recognise that the inhabitants of ticketed houses form a distinct class within the general body of inhabitants of one- and two-room houses. Nor are they an inconsiderable class. The total number of ticketed houses in the city is 23,288—namely, 16,413 houses of one room, and 6,875 of two rooms. About 11 per cent. in each case were found empty, so that we have 14,642 inhabited houses of one room, containing 46,463 inmates, and 6,157 inhabited houses of two rooms, containing 28,704 inmates. It thus appears that 35 per cent. of the whole population of our one-room and 14 per cent. of the whole population of our two-room houses have their houses ticketed. Let us endeavour to understand how these people are differentiated from their neighbours. In doing so, I shall make reference to those admirable model buildings recently erected by the Corporation in the Saltmarket, using them to furnish us with datum points in this social survey. They could not be ticketed, being far above the limit fixed by the Police Act, but I have had a census of the inmates taken, and have obtained measurements under the same restrictions as are applied to ticketed houses.

I. Observe, first, that almost without exception those ticketed houses are what we call "made-down houses." No plans of these houses were ever submitted to the Dean of Guild Court. They may be either, as in the older parts of the city, in tenements erected long before the Police Act of 1866 for the gentry of old Glasgow, or in tenements which have passed the Court recently as houses of three, five, eight, or ten rooms. In short, these houses have all been parts of houses of larger size; often parts of single rooms of houses of larger size, divided by partitions, sometimes of mere wood, run across the floor of those large rooms. This means defective ventilation, defective light, dark lobbies, crowded stairs, and disproportion in the conveniences provided. The proprietor may of his own motion have done something to add to those conveniences. The Sanitary Department may have compelled him to do more. Something may have been done to improve the light and ventilation when disease has brought the inspector upon the scene. But, after all, there remains the fact that tenements of small houses which demand the greatest architectural care and skill to make them physically wholesome, are evolved from structures designed for occupation under totally different conditions. I need scarcely point to the Saltmarket houses as illustrations of the application of foresight and thought to adapt structure to mode of occupation. These aim at the highest standard. The small houses which are not ticketed were either designed as such, or belong to the best class of made-down houses, where a necessary process has been intelligently and conscientiously carried out before occupation, and this is all that is wanted.

II. So much for defective surroundings and accessories: let us now go inside the ticketed house. We find that the average air-space of a one-room house is 1,058 cubic feet; the average number of inmates is 3·17, so that the average air-space per inmate is 334 cubic feet. I make no distinction between adults and children, because it is one which is not physiologically justifiable, and besides it would involve more complicated calculations. The average air-space of a one-room house in the Model Buildings is 2,213 cubic feet, the average number of inmates 2·92, and the average air-space per inmate 758 cubic feet. This is also a high standard. The ordinary non-ticketed one-room house ranges in capacity between 1200 and 1350 cubic feet, and is never crowded down to the legal minimum per inmate. Turning to the ticketed two-room house, we find that the average total air-space is 1,725 cubic feet, the average number of inmates 4·66, and the average air-space per inmate 370 cubic feet. In the Model Buildings the average air-space of a two-room house is 3,158 cubic feet, the average number of inmates 4·29, and the average air-space per inmate 736 cubic feet. The non-ticketed two-room house is simply a duplication, or a little more than a duplication, of a one-room house, and is always occupied so as to keep far above the legal minimum. The ticketed house, then, is small of its kind to begin with, and owes its ticket to the constant disposition to overcrowding of its inmates. In fact, 13 to 14 per cent. of the one-room houses are found overcrowded when inspected during the night, and 6 to 7 per cent. of the two-room houses. Of the inmates of the ticketed one-room houses, 5 per cent. are lodgers; of the inmates of the two-room houses, 6 per cent.

III. What do these people pay for this accommodation? These houses are taken by the month or by the week. I therefore give monthly rents. These vary slightly in different districts.

A ticketed one-room house reaches the lowest average rent in the "Calton," namely, 6s. 1d.; and the highest average, in the small district of "Brownfield," is 9s. 9d. A ticketed two-room house reaches the lowest average in a bad part of the district we call "Monteith Row," namely, 7s. 9d.; and the highest, which is in "Anderston," is 12s. 6d. But if I were to go into the details of the districts I should weary and puzzle you. Let us discuss the average for the whole city. The rent of a one-room house is 7s. 11d. This is 29·96 pence per inmate, and at the rate of 90 pence per 1000 cubic feet of air-space. The rent of a two-room

COMPARATIVE RENT AND AIR-SPACE
IN
TICKETED HOUSES AND MODEL BUILDINGS.

	Total Cubic Space.	Average No. of Inmates.	Cubic Space per Inmate.	RENT. Per Month.	Per Inmate.	Per 1000 Cub. Ft.
ONE ROOM.						
					D	D
MODEL,	2,213	2·92	758	13/4	54·8	72
TICKETED,						
Whole City,	1,058	3·17	334	7/11	29·96	90
"Bridgegate,"	1,130	3·12	362	6/11	26·6	73
"Cowcaddens,"	930	2·82	330	8/	34·0	103
"Calton,"	976	2·85	343	6/1	25·6	75
"Brownfield,"	1,044	3·04	343	9/9	38·5	112
TWO ROOMS.						
MODEL,	3,158	4·29	736	16/4	45·7	62
TICKETED,						
Whole City,	1,725	4·66	370	10/3	26·39	71
"Bridgegate,"	1,777	4·77	373	9/6	23·9	64
"Cowcaddens,"	1.752	4·83	363	10/3	25·5	70
"Monteith Row,"	1,659	3·61	460	7/9	25·8	56
"Anderston,"	1,615	4·67	346	12/6	32·1	93

house is 10s. 3d. This is 26·39 per inmate, and at the rate of 71 pence per 1000 cubic feet of air-space. If, therefore, we look to the inmates accommodated, the inmate of a two-room house pays 3·57 pence less for 36 cubic feet more air-space than the inmate of a one-room house. If, again, we regard the rent as coming from one pocket, the tenant of a two-room house pays fully 29 per cent. more rent for 63 per cent. more air-space than the tenant of a one-room house. He pays 71 pence per 1000 cubic feet, while the one-room tenant pays 90 pence. We shall be better able to discern the full meaning of these points if we turn to the Model Buildings and consider the whole facts together. There the rent of a one-room house is 13s. 4d. This is 54·8 pence per inmate, and at the rate of 72 pence per 1000 cubic feet of air-space. The rent of a two-room house is 16s. 4d. This is 45·7 pence per inmate, and 62 pence per 1000 cubic feet of air-space. There the inmate of a two-room house pays 9·1 pence less for 22 cubic feet less air-space than the inmate of a one-room house; but the tenant of a two-room house pays 22½ per cent. more rent for 42 per cent. more air-space. He pays 62 pence per 1000 cubic feet, while the one-room tenant pays 72 pence.

Observe, in the first place, that both in the ticketed houses and the Model Buildings the tenant of a two-apartment house gets better value for his money than the tenant of a one-apartment house. In the ticketed house he gets 1000 cubic feet of air-space for 19 pence less; in the Model house for 10 pence less. It is evident that in the Model Buildings the design has been to be generous to the tenant of the one-room house both in air-space and rent. Still, both cases illustrate the economic law that the greater the number of transactions necessary to dispose of the same quantity or amount of a commodity, the greater the margin which must be allowed to cover risk and outlays. The more a customer takes, he may expect to get the commodity at a diminishing rate per unit of that commodity. The larger the house, the less it will cost per unit of space, so that the man who lives in one room pays much more for his space than the occupant of the self-contained house. Poverty, instead of receiving discount, has to pay interest. But what shall we say about the other fact, that the tenant of the Model house pays less per 1000 cubic feet of air-space than the tenant of the ticketed house? Well, he takes more of it, he takes it for a year and he pays quarterly, and this ought to give him some advantage. A man who buys a quarter of an ounce of tea and pays it by instalments cannot expect to have it at the same rate per ounce as the man who buys a pound. But what if, after all, his quarter-ounce of tea is chiefly sloe-leaves? This is precisely the position of the man who rents a ticketed house. He pays 18 pence more per 1000 cubic feet in his one-room house and 9 pence more per 1000 cubic feet in his two-room house than he would in the Model Buildings, and yet, compared with the article he would get in those buildings, that which he accepts is but as sloe-leaves to the finest product of China. Just cross the street from those buildings and you find yourself in the district of "Bridgegate and Wynds," where the rent of a ticketed one-room house averages only 6s. 11¼d., and of a two-room house only 9s. 5¾d.—the most wretched houses in the city, although in cubic space they are above the average of the ticketed class, because they are so often fragments of the houses of the old gentry. Even there the tenant pays 74 pence per 1000 cubic feet of his one room, and 64 pence per 1000 cubic feet of his two rooms, which is in each case 2 pence above the Model Buildings rate. If we include the sculleries in the Model Buildings, the rent per 1000 cubic feet is reduced to 64 pence and 54 pence, respectively, which is in each case 10 pence below the rent across the street, where there are no enclosed sculleries, or water-closets, or, indeed, any of the elements of health or comfort.

There is something more than poverty in the problem of the high rent paid by the tenant of the ticketed house—high absolutely, and still higher relatively to the quality of the article obtained. He not only pays interest on his poverty, but on his character. Those 75,000 people comprise not only the criminal class, but the whole social *debris* of this large city; some who are bravely struggling with poverty, and far more who are alike bankrupt in character and in fortune. They are the nomads of our population. If we could see them in their constant movements from place to place the sight would resemble nothing so much as that which meets our eye when we lift a stone from an ant's nest. The City Assessor will tell you that they change their location in hundreds every month. They

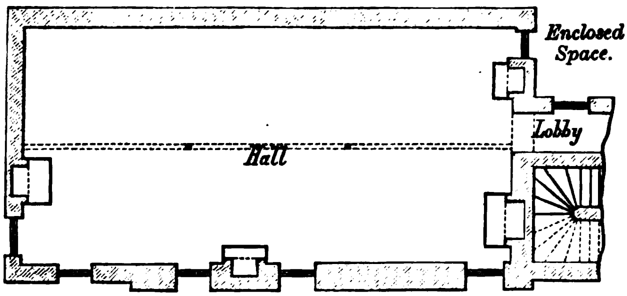
"Fold their tents, like the Arabs,
And as silently steal away,"

leaving, too often, their public and private obligations behind them. Yet their flittings cause no stir in the street. You may see the woman with her gown turned up over her shoulders, so as to enclose a few pots and pans and articles of crockery, while the man carries one of those skeleton-like grates on his back, and the children a chair or a stool, or a meat-can with a string fastened across the mouth to serve as a handle to this improvised pitcher. Those who are more luxuriously furnished can transport their whole property in detachments, with the help of a neighbour or two, in an evening. Poor things, their condition illustrates the old proverb, that "beggars cannot be choosers." If you look in upon them and remark on the discomforts of their house, your sympathy makes them eloquent at once. They are sure to say, "It is not fit for a dog to live in;" but, when you ask them why they stay there, they are silent. You ask what is their rent, and they tell you. You say, "Dear me! you will get a nice little house for the same money at such a place." Their immediate reply is, "Ah, sir! they won't take the likes of us there," which means that there they must pay their rent regularly, be cleanly, have no riotous outbreaks on Saturday nights, and, in short, reform their habits and their lives. So they are thirled to their ticketed house, and become the bond-slaves of their landlords—afraid to complain—paying dearly for a bad article. What can be done for these people? Does the erection of the Model Buildings bring any advantage to them? I must answer, No! You will not receive them there; and why? You have provided wholesome houses, and you feel you have a right to select your tenants, and that commercially you can do so. If every landlord had provided himself with a sound article—sound in a much more moderate sense than the Model Buildings—he would, both morally and commercially, be in a position to select his tenants, even the humblest of them, and so put a universal premium on good living. But just cross the Saltmarket again, and ask yourself how the owner of such property could select his tenants? Even if morally a man could convince himself that he had a right to pick and choose, commercially it is impossible; and for commercial reasons it is not done, and cannot be done. You might as well try to sell butterine as fresh butter in the West-End, or offer sloe-leaves for tea or sand for sugar, and insist that your customers shall be well-dressed and intelligent, pay ready money, and always say grace before eating your rubbish. After you have done your best to provide a fairly-honest house, you *may* select your tenants; and when you have an honest intention to keep your property in repair and keep down nuisances, you *may* appoint a care-taker to see to the conduct of your tenants, but not before. The housing of bad tenants involves morally the inner consciousness that you deserve no better, and, commercially, the knowledge that you dare not look for better.

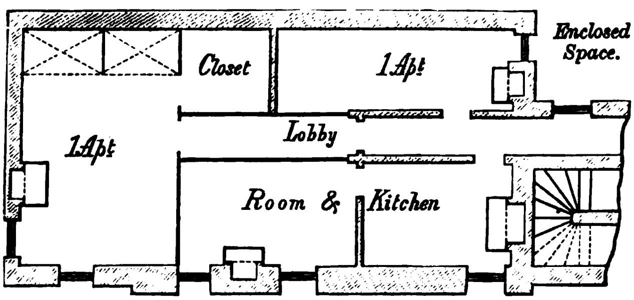
Looking at this problem of house-accommodation calmly in the light of reason, common-sense, and morality—What is the duty of public authorities and of the community in a private capacity?

The duty of authorities is to get the power, if they have it not, and to exercise it if they have, to improve the dwellings which exist by reforming and weeding out the bad, and seeing that the small houses which are being provided are up to a reasonable standard of wholesomeness. This is a wide general statement, and I wish to give it practical point by specifying shortly some powers which the authorities here do not possess, but which I trust will seem so reasonable that they will commend themselves to your approbation.

There is this process of "making down" houses. We have seen that one- and two-room houses are not bad *per se*, but only when bad houses and indifferent people are brought on inevitable commercial principles together. Is it reasonable that a man should be compelled to submit plans of new buildings to a responsible court, and yet not be compelled to submit plans when he proposes to alter the mode of occupancy and, therefore, the whole previous careful arrangement and adaptation of structure and convenience, light, and ventilation to the number of families and inhabitants? Why wait until the thing is done and disease appears, and then, by a tedious process, with an array of experts, compel, or endeavour to compel, alterations which can only prevent future mischief, but cannot restore broken health or revive lost lives? The process of "making down" houses is a lucrative one to the original owner. I may mention two of the most recent illustrations which have come under my notice. In one case a tenement containing six houses of six apartments, which stood one year at a rental of £175 on the valuation roll, was subdivided into 12 houses of three apartments, and was returned next year at a rental of £222. In another case a tenement containing six houses of four apartments, which stood one year at a rental of £78, was subdivided into 21 houses of one room, and was returned next year at a rental of £134. Neither case is an example of the worst forms of "making down," but there was no expenditure incidental to the change at all equivalent to the profit of the transaction, still less adequate to the requirements of health. It is the owner who makes this change who ought to bear the cost of alterations. When the property is sold it is sold at the increased rental. Not uncommonly the first effect of the intervention of the Sanitary Department is to lead to such a sale; and then, of course, any expenditure becomes a loss to the new owner. I do not object to "making down" houses. The "made-down" house is as necessary as a second-hand clothes market. I say it must be regulated, and until it is regulated all our efforts to raise the standard of the small dwellings of Glasgow will only resemble the labour of Sisyphus.



Property as it was.



Property as it is.

I here show two plans which illustrate well the liberty which may be taken by proprietors in the way of manufacturing small houses by this process, so long as they do not interfere with the external walls, and thus bring their operations under the review of the Dean of Guild Court. This alteration was effected a year ago, and was only discovered when an epidemic inspector came upon some suspicious cases of disease which I was asked to see. One plan shows a hall or workshop which had ceased to bring in a satisfactory rent to the owner. He accordingly subdivided it as shown in the other plan, producing two houses of one apartment and one of two apartments. The thick hatched lines show the portions of the necessary partitions which were built of brick, the remainder, in thin lines, being merely wood. It will be observed that the back main wall is a "dead wall," that is to say, it contains no windows or other apertures. There can be no ventilation of the large single apartment, so that the end occupied by the beds and the room called a "closet" are filled with stagnant air, which there is no possibility of renewing. The single room against the dead wall has only a small window opening into a "well" or space enclosed by other buildings. So long as small houses can be produced in this irresponsible fashion, insanitary dwellings will spring up in one place as fast as they are abolished in another. This glaring case was discovered by the incidence of disease, and can only be remedied by a process under the Public Health Act, expensive to all parties, and possibly ending in a poor compromise.

We also want in Glasgow the following summary method of dealing with unwholesome houses, the steady application of which during the last nine years goes far to account for the almost unexampled improvement which has taken place in the health of Edinburgh. I quote from the Edinburgh Police Act (1879), section 206:—

"206. If the Medical Officer of Health and the Burgh Engineer shall certify in writing to the Magistrates and Council that any house or building, or part of a house or building, is unfit for human habitation, the Magistrates and Council may, by their order, affixed conspicuously upon such house or building, declare that the same is not fit for human habitation, and it shall not, after a date in such order to be specified, be inhabited; and every person who shall, after the date or time mentioned in such order, let or occupy, or continue to let or occupy, or suffer to be occupied, such house or building, or part of such house or building, shall be liable to a penalty not exceeding five pounds, and a further penalty not exceeding forty shillings for every day during which such occupation is continued, provided always that before pronouncing any such order the Magistrates and Council shall call upon the owner to show cause against the said certificate within such reasonable time as they consider proper, and shall give such owner an opportunity of being heard before them, and, if he appear, shall hear him and such evidence as he may adduce; provided, also, that if at any time after such order has been made, the Magistrates and Council shall be satisfied that such house or building, or part of such house or building, has been rendered fit for human habitation, they may revoke the said order, and the same shall thenceforward cease to operate. The Magistrates and Council shall also, at such times as they shall fix, hold open courts for the consideration and disposal of appeals against such certificates, and it shall not be necessary that a majority of the Magistrates and Council be present to constitute such courts; provided, further, that the preses of such court shall have a deliberative as well as a casting vote."

You will observe that this constitutes the representatives of the people of Edinburgh, advised by their officials, the final judges when a house is "unfit for human habitation," and they are clothed with the most effective means of compelling the owner to make it fit for habitation—namely, the power to make it cease to be a rent-producing subject until the requisite improvements are effected, if improvement is possible. By a general clause in the Act the Town Council may devolve their functions on committees. This function is therefore vested in the Health Committee, sitting as a court, presided over by its chairman. This is an illustration of a principle which is applied throughout the States of America: that the Board of Health, elected by the people, shall be clothed with summary power to protect the health of the people. It would certainly open the eyes of some folks to read the "Manual for the use of Boards of Health of Massachusetts, containing the statutes relating to the public health, and the decisions of the Supreme Courts of Massachusetts relating to the same." One of these decisions, for example, is to this effect:—"The adjudication of the Board that a nuisance exists is conclusive, and no appeal lies therefrom." All the City Boards of Health in this State have the same summary powers as the Edinburgh Health Committee over house property, but embracing any and every condition or circumstance which is "a cause of nuisance or sickness to the occupants or the public." Still more worthy of the study of the people of this country is the "Tenement House Act,"* passed last year by the "People of the State of New York, represented in Senate and Assembly." I shall quote only one clause, in the hope that it may

* A tenement-house is thus defined in this Act:—

"Every house, building, or portion thereof which is rented, leased, let or hired out to be occupied or is occupied as the home or residence of three families or more, living independently of each other, and doing their cooking upon the premises, or by more than two families upon any floor, so living and cooking, but having a common right in the halls, stairways, yards, water-closets, or privies, or some of them."

Various specific provisions with reference to houses so occupied are worth noting, for example:-

attract attention to the unexhausted resources of legislation for the amelioration of the social difficulties of the day, if only the people will wake up to the fact that health has proprietary rights as well as heritable property :—

"§ 659. Whenever it shall be certified to the Board of Health of the Health Department of the City of New York, by the Sanitary Superintendent, that any building or part thereof in the City of New York is infected with contagious disease, or, by reason of want of repair, has become dangerous to life, or is unfit for human habitation because of defects in drainage, plumbing, ventilation, or the construction of the same, or because of the existence of a nuisance on the premises, and is likely to cause sickness among its occupants, the said Board of Health may issue an order requiring all persons therein to vacate such buildings, or part thereof, for the reasons to be stated as aforesaid. Said board shall cause said order to be affixed conspicuously in the building, or part thereof, and to be personally served on the owner, lessee, agent, occupant, or any person having the charge or care thereof; if the owner, lessee, or agent, cannot be found in the City of New York, or do not reside therein, or evade or resist service, then said order may be served by depositing a copy thereof in the post office in the City of New York, properly enclosed and addressed to such owner, lessee, or agent, at his last-known place of business, or residence, and prepaying the postage thereon; such building, or part thereof, shall, within ten days after said order shall have been posted, and mailed as aforesaid, *or within such shorter time, not less than twenty-four hours*, as in said order may be specified, be vacated; but said board, whenever it shall become satisfied that the danger from said building or part thereof has ceased to exist, or that said building has been repaired so as to be habitable, may revoke said order."

I cannot better illustrate the difference between this sort of legislation and ours than by quoting an instance in which a single-apartment house had an open drain beneath the floor. The mother complained to us because the rats, walking in and out of this hole, alarmed her lest they should bite the children. Weeks

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Water-closets, privy-sinks, or other similar receptacles, to be provided at the rate of not less than one for every two families.

Each occupant of a tenement-house must have not less than 600 cubic feet of air-space.

Whenever more than eight families live in any tenement-house, in which the owner thereof does not reside, there shall be a janitor, housekeeper, or some other responsible person, who shall reside in the same house, and have charge of the same, if the Board of Health shall so require.

were spent in serving notices, inspecting, certifying, and again notifying, before the proprietor removed this abominable nuisance.

After everything has been done by Parliament and by Local Authorities which can be done to exterminate unwholesome houses, and banish "adulterated" property from the market as resolutely and successfully as adulterated food, there will still be a necessity for the assistance of private effort. The public of Glasgow trust too much to authorities and officials for the solution of their social difficulties—more, I think, than any other community. Where are the "Open-spaces and Playgrounds Associations," the "Artizans' Dwellings Companies," and the like, which unite the business capacity and Christian sympathy of the citizens of so many other cities in successful labour for the common good? Why have we not an Octavia Hill in Glasgow? There are various ways in which private associations might help to elevate the 75,000 inhabitants of the ticketed houses of this city. They might attack the question of building new tenements of small houses, to be let at monthly rents, to return a modest interest on the outlay, and yet be within the means of those who could be tempted to try to lead orderly lives if they had the chance of physical circumstances which would help them up and not help them down, or keep them down. They might buy a tenement here and there which could be "made down" in an honest fashion, and yet yield a reasonable return on the money invested. They might acquire a poor tenement, and try to acquire the poor tenants also, and make them feel the elevating influence of the introduction into the relation of landlord and tenant of friendly interest and moral responsibility. Or they might undertake the factorage of such properties held by private individuals, administering them on the principle that the maintenance of the property shall be the first charge on the rental. These last are undoubtedly the best directions which private enterprise can take. They are the methods of Miss Octavia Hill and those who work under her. They are far better than building model houses, selecting the good and casting the bad away, even if the good belong to the class for whom they were intended, which they seldom do. It is the people you reject who require your help. If you go on selecting you merely leave somewhere in the city a more utterly hopeless and homogeneously bad residuum. Read Miss Hill's book on the "Houses of the London Poor," in which she relates her practical experiences. You will find that she is no soft sentimentalist, spoiling the poor by shutting her eyes to their frailties, and subverting the order of the universe by making intemperance and vice comfortable. She first convinces them that she will do her duty by them as their landlady, and then exercises the moral right which she has thus acquired, and which they do not fail to recognise, to make them pay their rents regularly, and otherwise do their duty by her. If the relationship between landlord and tenant is of this nature, no more powerful influence exists than that which the landlord possesses over the poor, unless it be that which exists where the relationship is commercial and not moral. The difference is that the former makes for the good, the latter for the evil. In the one case the eyes of both meet on rent day, with a consciousness of mutually-unfulfilled duty. The one winks at the derelictions of the other. In the other case the landlord's eye is friendly but firm with a sense of rectitude, and there is no flaw in his relations to which the tenant may appeal for excuse or defence.

II.—*Sanitary and Social Problems.* By JOHN HONEYMAN, F.R.I.B.A., being his Opening Address as President of the Sanitary and Social Economy Section.

[Read before the Society, 5th December, 1888.]

IT is usual to allow a President in his Inaugural Address a considerable amount of latitude, and I feel that I shall need your most kind indulgence in this way, however carefully I may limit the scope of my remarks. For the subjects which properly come under the cognisance of this Section, which are strictly connected with sanitation and social economy, are at once so important, so varied, and so multitudinous, that it is extremely difficult to make a selection; and I am not content merely to review what has been done in the past; I desire, rather, to direct your attention to points which immediately concern us, and which must be dealt with in the near future, my primary object being to arouse fresh interest in these, and so to stimulate the members of this Section to greater activity in the work of elucidating sanitary and social problems and giving them a practical turn. For it is undoubtedly true and a melancholy fact that, notwithstanding all the light which has been thrown upon such subjects in recent years, all the powerful appeals which have been made to the intelligence, the patriotism, the philanthropy, and even the selfishness of men, the progress of amelioration is still slow and fitful, and the continued apathy and ignorance of the general public lay a heavy burden of responsibility on the members of such a Society as this, whose members profess to understand what the well-being of the community requires, and to realise the consequences of indifference. Having regard to these circumstances, it is evident that the interference of such an influential Society as ours in active sanitary and social legislation is not merely justified but required by a due recognition of our responsibilities—responsibilities self-assumed, no doubt, but not the less on that account real and onerous. We have, it must be admitted, not been entirely negligent of these in the past, although we have occasionally relapsed into a kind of moribund state. We have done good service both in an educative and a legislative way, and if the effect be difficult to trace, it by no means follows that it has been insignificant. One thing at least I do not hesitate to say, which is that the best advice our law-makers have had in connection with that ponderous measure, till within the last few weeks still dragging its cumbrous bulk through Parliament—the Burgh Police and Health Bill—has proceeded from this Society; and although our advice as to a new Health Act for Scotland has not been taken, it appears to me that if we are still satisfied, as no doubt we are, that it was founded on reason and necessary for the well-being of the community, we ought by all means to press it still upon the notice of those in authority. I can hardly doubt that we would do so now with a better chance of success than formerly, for not only have the anomalies of our Health Acts become more apparent, but we have at present in office a Scottish Secretary who has given abundant proof of his readiness to receive and to weigh with impartiality representations on such questions.

You will remember that one of your recommendations was that the Burgh Police and Health Bill should be divided into three different measures: A Police Act, a Health Act, and a Building Act. This division was first suggested by the Glasgow Institute of Architects, when the Glasgow Corporation, in 1882, drafted a "a hodge-podge" Bill, which they were induced to abandon by Lord Advocate Balfour, on the ground that he was introducing a general measure of similar scope and character, which would give them all they wanted. That Bill has not yet become an Act—it is the same old perennial, clumsy measure to which successive Lords Advocate have affectionately clung, even unto the present day, and which has in the meantime been withdrawn. If Lord Provost Ure and his Council had listened to the representations of the Glasgow Institute of Architects there cannot be a shadow of doubt that a Police Act and a Building Act would have been passed long ago, and most probably a Health Act also. But it took our Town Council several years to see, or at least to acknowledge, that the course recommended by the Institute was right, and by that time one Lord Advocate after another had pledged himself to carry through the Bill as it stood. Nothing has astonished me more in this connection than to find that men like Mr. J. B. Balfour and the late Lord Advocate, now Lord Justice-Clerk—accustomed not merely to sift facts, but to forecast their bearings—have failed to realise that the passing of the present Bill, with its utterly inadequate Health and Building regulations, would simply mean the postponement indefinitely of any satisfactory legislation on these subjects. Once more we have an opportunity of letting our voice be heard on this subject, and we may now, perhaps with considerable prospect of success, address the new Lord Advocate before he commits himself to any special line of action. The apathy of the various corporations is remarkable. It almost seems as if they were afraid that a Health Act would interfere with their patronage—would prevent them, for example, giving the lucrative appointment of Sanitary Inspector to a common policeman, in terms of Lord Advocate Balfour's Bill!

Another matter in which we have more recently taken an interest is the regulation of burying-grounds, and, as intimately connected with this subject, the general question of the disposal of the dead, more particularly by cremation. It has always seemed to me surprising that, in this age of blast furnaces of every variety, the idea of consigning our dead to one did not occur many years ago, and that we should only now be giving practical effect to it in a tentative fashion. It is a remarkable illustration of the power of sentimentality, which in this case has been able, with some aid, no doubt, from superstition, to make reason, expediency, and science kick the beam. I attribute the slight turn in the scale observable lately chiefly to the waning power of superstition. There are many indications of the vast change which has occurred in Scotland in this respect within the last quarter of a century, and I greatly mistake the character of my fellow-countrymen if, having once recognised the falsehood of cherished notions, they do not speedily emancipate themselves from their thraldom. Perhaps it is not wonderful that men who believed—as almost every Scotchman believed forty years ago—that every atom of the human body, without loss of identity, but with the added attribute of incorruptibility, was destined to be preserved and utilised in another sphere, should shrink from the deliberate destruction of these atoms by such a summary process as cremation. But that superstition—a belief in the resurrection of the body as set forth in creeds and catechisms—is fast dying out. There are, it is to be hoped, comparatively few intelligent men who still cling to it, and there are thousands now for one in former times able to appreciate the fact that by burial the human body is as certainly and as effectually destroyed as by cremation; so that the only remaining figment which can be imagined as influencing even the most orthodox is, that in the one case he is not responsible for what happens to the atoms; he commits them to the grave in the sure hope that they will be preserved and brought together again; —in short, he throws the whole responsibility on the Almighty; whereas, in the other case, he accepts the responsibility himself, and the sure and certain hope dissolves and vanishes in the fumes of the crematory. But even this idea must cease to trouble the weakest brother so soon as he recognises the fact that the one course, producing precisely the same results as the other, involves precisely the same responsibility, and in no respect whatever increases the difficulty of the expected miracle.

There is absolutely no religious question involved, nor any healthy sentiment except that conservative sentiment—within certain limits worthy of all respect—which leads us to venerate and perpetuate time-honoured customs, especially when they are in any way associated with the memory of those we have loved and lost. But, gentlemen, while I own to being myself influenced greatly by what may be called the archæological sentiment, it appears to me that there are, as I have just hinted, certain limits to its legitimate sway, beyond which subserviency becomes synonymous with prejudice. Beyond that limit sentiment must not intervene, that is to say, beyond the point where common-sense and sentiment come into conflict, where it is evident that utility, health, and the general well-being of the community must be sacrificed if sentiment is to prevail. Now in the case of cremation the issue is clear and unequivocal; and what I think makes the early success of the movement in Scotland likely is this, that we are not an ultra-sentimental people; and if we be still in some things "too superstitious," we are ever more ready than our brethren in the South to enter upon a new course which is obviously right and beneficial, brushing aside remorselessly old prejudices and preconceptions. On these grounds I believe we may anticipate a more rapid development of cremation here than in England, which has got the start of us, and the change will, I am sure, be welcomed by all who are interested in sanitary science. The action which during the past session this Section took with reference to burial regulations, and the graphic and ghastly statements of Dr. Duncan, Dr. Christie, and others, abundantly demonstrate the need of reform, speedy and drastic, which is surely within our reach, if we could but persuade men to think sometimes of what happens when the "narrow house" is overcrowded, and to look the plain facts, the foul reality, in the face. Imagination here should prove an effective antidote to sentiment.

There is, alas! a too close connection between our overcrowded burial grounds and the overcrowded dwellings of the poor. This was clearly demonstrated by our President in the admirable address with which he opened this session, and which no one, I am sure, could listen to without emotion. It was a clear, dispassionate statement of fact, and Dr. Russell has once more laid us under a debt of obligation by his careful investigation of the connection between small houses and high death-rates. But in this case it is almost as well for us if, looking beyond these cold facts and statistics, we fail to realise their full pathetic significance. The tale of these "ticketed" houses—the abject poverty, cold, hunger, sickness, and death, not of one poor, struggling, honest household, but of thousands, and the vice, the crime, and deepest depth of misery of thousands more, are something too frightful for contemplation, and yet too directly personal to be ignored. It is difficult to imagine any man with sensibilities so blunted—"with soul so dead," that he should not recognise and acknowledge the claim which these poor people, these fellow-citizens, have upon him orf help. Yet public apathy continues, the only intelligible explanation being that, while the great majority of the better classes have no conception of the existing horrors, those who have are paralysed by a sense of the magnitude of the evil, and the seemingly insuperable obstacles which prevent amelioration.

Some years ago a good deal of harm was done by the late Dr. Farr's want of discrimination in dealing with statistics which, he held, proved that the rate of mortality depended on the density of population. This seemed to confirm the erroneous theory which lay at the root of our own City Improvement Scheme, and against which I, among others, protested at the time of its inception—namely, that the dispersion of the population over a wider area was the best means of securing the proper housing of the poor. This view was at once superficial and fallacious. It was *superficial*, because it ignored the fact—recorded in the report of the Royal Commission on the Housing of the Working-Classes—that the root of the evil is to be found in "the poverty of the poor." That is the depth below the surface which we must reach if we are in earnest—a depth so dark, so mysterious, so beset with difficulties as to bid the boldest pause. It was *fallacious*, because it attributed to density of population a result due to concomitant but absolutely independent causes. There is, in fact, no necessary connection between density of population and a high death-rate. Dr. Russell brings us much nearer the truth when he shows us the connection between small houses and high death-rates, although, as he himself acknowledges, even this only brings us a step nearer the real causes of mortality in crowded districts—poverty, starvation, vice, disease, and foul air in overcrowded, badly-planned houses. This is strikingly illustrated by the comparison which he made between the state of matters in St. Rollox and Bridgegate districts, having practically the same proportion (fully 83 per cent.) of one- and two-room houses. Dr. Russell* finds that, whereas in the St. Rollox district the deaths were at the rate of 23 per thousand, in Bridgegate the rate was 42—the difference being (no doubt correctly) attributed not to greater overcrowding, but to the bad arrangement of the houses and the greater degradation of the population. There are special difficulties in the way of converting houses of a good class into houses of the lowest class with a due regard to sanitation, and, as the authorities have no control over the converters, who are simply actuated by a desire to draw as much rent as possible from their property, in many cases knowing little and caring less for sanitary requirements, there is no wonder that so large a proportion of the 23,000 "ticketed" houses should be unfit for human habitation. Dr. Russell exhibited some typical examples of how this species of conversion is effected, and I may incidentally refer to one of them as a good illustration of a defect in house-planning, which very few recognise as such. The plan showed an oblong room, with the door near the middle of one side and the fire-place opposite it, a window at one end but no opening at the other. The effect of this arrangement is that the space between the fire-place and the blank end-wall will remain entirely unventilated. Dr. Russell pointed this out, but it is really no easy matter to convince people that it is possible to pass a sufficient supply of fresh air through a room without ventilating it at all. It is one of those sanitary facts which require to be repeated over and over again, and dinned into people's ears, in order that it may receive the attention which it deserves. Of course, it is quite clear to any one who will take the trouble to think of it, that the only exit for

* Opening Address, p. 11.

air being the chimney, and the only inlets the window and door, it is possible to have the one half of the room pretty well ventilated, while in the other half the air is hardly disturbed. But the probability is that in actual practice the window would be carefully closed and the whole supply of fresh air would enter by the door. From this it would go direct to the fire-place without perceptibly affecting the condition of the air above the level of the fire-place lintel, even over the area of the room which it traverses, the fresh air most likely being admitted chiefly *under* the door. Gentlemen, most of you, I have no doubt, understand all this as well as I do myself, but it is extraordinary how many people do not understand it, or who act as if they did not, and who regard these aërial cesspools with perfect indifference.

These foul air accumulators are of two kinds, either lateral, as in the case under notice, a variety most common in old converted houses; or vertical, as in houses of a superior class, where ceilings are high in relation to the floor areas, and there is little to choose between them. That is a fact which many seem to doubt, the popular nòtion being that a high ceiling is sure to make a wholesome room. This is a mischievous fallacy, but I can only find time to say a few words about it now. Let us take a "ticketed" house of about the average capacity, 1050 cubic feet, with five inmates, and consider how it will fare with them if their foul-air accumulator is of the lateral or vertical type. In the one case we may assume that the room will be 12 ft. × 12 ft. × 7 ft. 3 in. high, and in the other 10 ft. × 10 ft. × 10 ft. 6 in. high. In both cases the inmates would only have 210 cubic feet each, and even with this small allowance it would be possible, with the aid of a good-going vent and a proper disposition of the inlets, to secure healthy conditions if the inmates got *the use of the fresh air before it reached the chimney.* But in the cases supposed they cannot possibly do so fully, or even approximately; and to whatever extent the fresh air passes up the vent unused, that is to say, unbreathed, in like proportion must the used air be utilised over and over again. Now, keeping this in view, let us imagine our poor inmates in bed, and consider what will happen in their respective dwellings. In the first the door will be opposite the fire-place, and the window in the end of the room. In the opposite end, beyond the door and the fire-place, there will be sufficient space for two beds. These beds will be under the level of the chimney opening. The fresh air will enter partly by the window and partly by the door. Passing along the floor for the most part, and across the room near the level of the ceiling at two points—namely, at the door and window lintels, a considerable proportion of it will be diverted from a direct course by the impetus of the draught from the window, by becoming heated, by pursuing the heated exhalations of the inmates, and by obstructions caused by articles of furniture, &c. From these causes it is evident that a considerable proportion of it will circulate through the room before escaping. It is also evident that the descending current of cold air from the top of the door must constantly draw with it a proportion of the foulest air next the ceiling. Stagnation in any part of the room is impossible, and it would appear that the lateral accumulator is practically annihilated if we only *make the ceiling low enough.* This would be a house utterly condemned by our Dean of Guild Court, and prohibited absolutely by the proposed Glasgow Police Bill, and the Burgh Police Bill, if these ever became law, and that on the ground that the ceiling is too low—the very thing, as we have seen, which makes the sanitary conditions tolerable. I do not hesitate to say that it would be healthier than if four feet were added to the height of the ceiling, bringing up the cubic space nominally to 325 cubic feet to each inmate, but giving each a smaller proportion of fresh air per minute, a larger proportion going right up the vent unused. But to further illustrate this, let us look at the second case, having a high ceiling and the same cubic capacity as in the first. The first difficulty here is to get two beds into the room. If the door be near the corner there will just be room to put the beds in two different corners, with their ends towards the door, but when so placed their inner corners would touch each other, so that access to the door would be entirely blocked, and it would be necessary to put the window very near the fire-place. The inmates would probably solve the difficulty by lying on the floor; but let us suppose that they get into their beds somehow, so as to be in the same position in relation to the floor as their neighbours in No. 1, this is what will happen: the mass of air above the level of the door will hardly be removed at all; in other words, about two-fifths of the total cubic contents of the room will be kept in the accumulator all night, a considerable proportion of it passing through the lungs of the inmates continuously. For the heat and breath of the inmates will cause a slight circulation of fresh air in this wise: the foul air as it cools down will certainly descend everywhere round the room, close to the wall, except over the fire-place; part of this descending current will be carried by the draught from the door and window towards the fire-place, but being warmer than the fresh air a good deal of it will rise again, and some will go up the chimney. But there will be nothing to check the current down the two quiet corners where the bed-heads are; the high cold wall will accelerate its downward course, and it is all needed to replace the air expelled from the lungs at the level of the beds; it is not required at a lower level, in fact, below that there is constantly a stratum of purer air at a lower temperature, on which, therefore, the foul air floats, as oil upon water. In these circumstances it is conceivable that none of the fresh air entering the dwelling is used by the inmates, and that they simply breathe all night over and over again the same air, nominally about 210 cubic feet each, but in reality only about half that quantity.

This digression has occupied more time than I intended, but it refers to a most important practical point constantly overlooked in the ventilation of apartments great and small, inhabited by the wealthiest as well as by the poorest.

Before passing from this subject, the dwellings of the poor, I must remark that nothing is more certain to aggravate all the evils which we at present deplore than the erection of dwellings for the working-classes by our Corporations; and it is astonishing to me that shrewd business men, as the majority of our Town Council are, fail to apprehend the futility, and the danger as well, of attempting to banish inexorable economic laws to Saturn or anywhere else. They are not to be got rid of at pleasure, and when violated they exact the penalty surely and remorselessly. The economist as well as the sanitarian finds it necessary to repeat constantly certain elementary truths such as this, chiefly, I believe, because the army of the ignorant is for ever being recruited, and partly because people don't wish to understand them; but whatever the explanation may be, his duty clearly is to "peg away" at them. On this principle, although I have publicly referred to this subject before, I must do so again. I have not a word to say against the buildings erected by the Corporation in the Saltmarket. I agree with Dr. Russell in thinking them excellent of their kind. But some of our Town Councillors seem to think that by the erection of these buildings they have done the ignorant architects and builders of Glasgow a good turn by showing them how to get up dwellings for the poor. Now that is an absurd mistake. There was no difficulty in designing or building dwellings quite equal to these in every respect, but the plain fact is that no sane builder would do anything so foolish, even if he were in the lucky position of being able to borrow money at 3½ per cent. It may suit the Corporation to erect these buildings so as to occupy and bring back population to some of their vacant ground, but to the community, apart from its slight interest in the "Common Good," these buildings are absolutely of no use either as models, or in any other way. Let us consider them a little—first, negatively—as old divines used to say—and, in the second place, positively.

Firstly—They are *not* dwellings for the poor. The Corporation, with all Dr. Russell's facts before them regarding the wretched condition of "ticketed houses," their faulty arrangements, and lamentable death-rate, might have been better excused had they attempted to show by their building operations some practical way of meeting this gigantic evil. A model block, showing how this could be done in a way sufficiently remunerative to tempt builders to imitate it, would have been of immense value, and could not have been objected to if the Corporation pledged themselves not to erect another. This will be more apparent when we consider, secondly, the positive aspect of their conduct.

When the first block was erected it was to be a model, but, as we have seen, it turned out to be a model which no sane builder would dream of imitating, because it would not pay him to do so. In the face of that fact, the Corporation resolve to imitate it themselves, with no excuse except that they can make it pay sufficiently to satisfy *them*. It is evident that they thus enter directly into competition with the builder, in circumstances which put anything like fair competition entirely out of the question. Now, unfair competition inevitably leads to monopoly, and I know nothing which in the long run would prove more injurious to the working-classes than a building monopoly. The Corporation are bound to consider not merely the immediate financial results to them, but also the consequences which must follow their driving the ordinary builder from the field, in the shape of scarcity of house accommodation and of increased rents; and they may depend upon it, that a continuance of their present policy will surely lead to these results. At the annual meeting of the Kyrle Society last week our respected Lord Provost made some eminently sensible remarks on this subject, and also on one-room houses, which I cordially endorse. If the Corporation really desire to benefit the working-classes in this matter, their simple and only safe course is to give up building definitely, and to sell their vacant ground at prices which ordinary builders can afford to pay.

But a much wider and more difficult economic question is suggested by the lamentable condition of the poor in all great cities, and in the country as well—a question which I cannot venture to touch upon now, but which properly comes within the scope of our Section's cognisance. I mean the great and interesting question of the better distribution of wealth. Except in so far as it contributes to this result, the better distribution of land is a matter of altogether secondary importance; but it seems to appeal more directly to the popular fancy and interested demagogues, and certain sections of the press have therefore made the most of it. We really need—and the need becomes pressing—something more radical still, something which shall affect every class of society, from the highest to the lowest, and every variety of industry and commerce, in the way of regulating the distribution of wealth, so that it shall conduce to the greatest good of the greatest number. But it is well that we should ever remember that it is vain to expect that anything of this kind has the slightest chance of success if it either violates economic laws or in any degree discourages individual enterprise. It can never be if either of these conditions be violated, and yet I venture to express the opinion that the accomplishment of this great means of ameliorating the condition of the poorer classes is not impracticable. If it be not, then there is no use railing at the "sweating system," or calling for legislative interference with it. We have had too much unwise legislative interference with trade already, and even at the recent anti-sweating demonstration here, Dr. Cameron, M.P., had to acknowledge that "the system had been stimulated by the operation of the Factory and Public Health Acts." Yes, and it must be further stimulated and the wretched condition of the poor assuredly made more wretched still by any further legislation which does not go to the root of the matter. That apparently was not the view taken by the meeting to which I have just alluded. A Mr. M'Lean, from Edinburgh, proposed seven different varieties of interference, one of which was a further extension of the Factory Acts, the others being all more or less restrictive and protective. He had to acknowledge that some of them might reasonably be objected to, but then "for that he cared not!" Now, it is just this kind of stupid superficial legislation which is the greatest curse to the poor. I am perfectly sure that neither Mr. M'Lean, nor any one else at that meeting, has more heartfelt sympathy for the poor or a more earnest desire to see their condition improved than I; but the more I think of it the more I feel convinced that you must deal with *poverty*, the root of all grinding "sweating" slavery, not by diminishing the chances of the unhappy victims getting any employment at all, but by increasing those chances by the combined means of a greater diffusion of money and enlightened public opinion. There is nothing inconsistent in a keen Conservative favouring a radical change in this respect; at all events, I regard the claims of our terribly down-trodden poor as paramount, and my complaint against my Radical brethren in this case is, not that they *go too far*, but that they *go astray*, and belie their profession and their name by ignoring altogether fundamental principles.

I need hardly point out that as you cannot increase the wages of the poor by throwing difficulties in the way of their getting work, no more can you facilitate their better housing by providing them with dwellings which they cannot afford to pay for. You quite as certainly *add to their woes* by the one course as by the other. It is a strong conviction of this which has led me more than once to protest against the imposition of such restrictions on buildings as have tended to keep the land belonging to the Improvement Trust vacant, and hindered the erection of dwellings of the humblest class. While so large a proportion of the poorer classes continue in their present abject condition, it is the height of folly to do anything which will have the effect of burdening them with heavier rents. We may be able to effect many improvements which cost nothing, and our sanitary authorities in Glasgow and other large cities have done much commendable work in this way; but such interference must not be carried beyond the rigid limit I have indicated, it must not increase the cost of the dwelling, or we do our poor brethren far more harm than good. Under present social conditions, then, there are two things almost equally essential to the well-being of the poor: First, That they do not get better houses than they can afford to pay for at less than a remunerative rent; and, Second, That nothing should be done by local authorities to diminish or hinder the supply of houses suitable to the circumstances of the poor, that is to say, so cheaply constructed that the poor can afford to pay remunerative rents for them. It seems impossible to drive the economic fallacy out of some people's heads that you can burden landlords without burdening their tenants. It matters not who pays the money in the first instance, it will never be paid by anybody who does not see his way to get it out of his tenants.

In the due recognition of this fact and of the limitations just mentioned we have the secret of Miss Octavia Hill's success. That lady and her noble band of associates have done more to improve the condition of the homes of the poor than any other organisation: and the reason is not far to seek. Miss Hill's fundamental principle is that the houses *must pay*, and she never violates that principle in order to make changes which she thinks very desirable, however anxious she may be to do so. She knows well the enormous advantage to the poor of low rents, and has proved that amelioration depends even more on good management, order, and cleanliness, and, above all, on the co-operation of the poor themselves, than on structural arrangements.

Here we have true philanthropy pressing the inexorable laws of political economy into its service, and therefore successful.

We must earnestly hope that the Kyrle Society may be encouraged to enter upon a similar work here. I think there can be little doubt that if they adhere closely to Miss Hill's method they will succeed, but I fear they must aim at obtaining from their property more than four per cent. Miss Hill obtains five per cent. after paying all expenses, including the usual commission for factorage; and if that is possible in London, there ought to be no difficulty about it here, and it would no doubt go far to insure the steady development of the greatly-needed and most praiseworthy work.

I must now bring these remarks to a close, but I am very unwilling to do so without some reference to what has been called "The Sewage Problem," which has within the last few days been once more brought prominently before us by Mr. Young, the Inspector of Cleansing. Mr. Young's proposal is probably the best which has been suggested. It is, in my opinion, the best non-precipitation scheme; but I must not discuss it now. All I wish to do in the few minutes still at my disposal is to remove a misapprehension regarding this problem, which I know has a very wide-spread influence. I wish to make it perfectly plain that this is not a sanitary problem. It does not come under our notice because we are the Sanitary Section, but entirely because we are the Social Economy Section. It is, in short, purely an economic problem. It is thirty years since, in a paper read before the Architectural Society, I endeavoured to convince my fellow-citizens of this same fact, but during all these years proofs of the fact have been accumulating. We have had, for example, the careful investigations into the condition of the air in different parts of Glasgow by a Committee of this Society and the testimony of such men as Professor Gairdner and the late Dr. Angus Smith. We have had the annual testimony of the registration of deaths in the different districts, and, lastly, we have had the remarkable fact that, notwithstanding the enormous increase in the quantity of sewage thrown into the river, the death-rate of the city has gradually fallen from something like 35 per 1,000 to the very satisfactory rate of 17.

In view of these facts, it appears to me to be perfectly absurd to say that the general health of the community is affected by the condition of the river. Why, then, should the citizens be asked to pay a large sum of money for its purification? Only one satisfactory answer to this is possible—namely, that the operation would be remunerative, that we would thereby turn our sewage to profitable account instead of wasting it. But how does the matter actually stand? According to this very reasonable and economical scheme of Mr. Young, the ratepayers of Glasgow would be saddled with an annual deficit of upwards of £44,000! And who are the ratepayers? I need not remind you how large a proportion of the rates in Glasgow comes out of the pockets of the working-classes. It is they who would have to pay the greater part of this sum, for which they would get absolutely nothing in return. In contrast with that result only imagine what £44,000 per annum might do for us if we left "the sewage problem" unsolved. Five years of it would solve several other problems in which the working-classes are very much interested indeed. They would give us a respectable library, a museum, a school of art, a technical college, and another park—substantial and permanent advantages, in the enjoyment of which the five years of heavy taxation would soon be forgotten. The economist, and especially the social economist, must be satisfied that he gets full value for what he spends, and when a proposal to spend so large a sum as £44,000 per annum is made there should be no difficulty in stating categorically the benefits which are thereby to be obtained. Health is not one of these—what is? It can surely be specified and appraised. I must confess that I have searched for it in vain

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III.—*Memoir of Mr. James Sellars, Architect.* By A. LINDSAY MILLER, Secretary of the Architectural Section.

[Read before the Society, 5th December, 1888.]

IT is fitting that the work of one so eminent in his profession as the late James Sellars should not pass away from our midst without some notice; for this purpose, at the desire of your Council, this short memoir has been prepared.

Mr. James Sellars was born on the south side of our city on December 2nd in the year 1843, and educated at a school in the neighbourhood. After the usual preliminary education, at the early age of thirteen years, he entered as an apprentice the office of Mr. Hugh Barclay (now of the firm of H. & D. Barclay), with whom he continued seven years. During his apprenticeship Mr. Sellars was an eager student in the profession which he had adopted, taking advantage of every opportunity of evening study after the work of the office. By the advice of Mr. Barclay he attended the School of Design, and several scholarships which he gained enabled him to meet the expense connected with his studies. He also attended the classes of the late Mr. Robertson, artist, so that he might become a skilful colourist. When the Society of Architects instituted their system of prizes for the best drawings by apprentices, Mr. Sellars carried off the first prize for his drawings of the front of the Hunterian Museum (then situated in rear of the old College in High Street), the able architect of our Municipal Buildings in George Square being second. He was afterwards three years under Mr. James Hamilton, whom leaving, he was employed in the office of Mr. Campbell Douglas, and at this time he, we may say, "won his spurs" by carrying off successfully in a competition the work of erecting the Stewart Memorial fountain in the West-End Park. This was a great effort for such a young man, since pitted against him were some of the leading architects in the city. But the great beauty of his design, both in form and colour, and its exquisite draughtsmanship, easily gained the prize, and at the same time drew attention to him, so that the profession felt even then that a new power had arisen amongst them. Architects before this were content with a more or less mechanical style of colouring and a slight stiffness in the preparation of their competitive drawings. This design of Mr. Sellars, exhibiting as it did beautiful draughtsmanship, helped—not hindered—by the colouring, changed the existing state of matters, and the younger members of the profession are indebted to Mr. Sellars for showing them how beautiful and at the same time useful drawings could be produced. I do not assert too much when I say that from this time a great improvement in the preparation of architectural drawings took place; and that this was greatly due to this early work, together with that of his earlier years in Mr. Douglas's office, I do not hesitate to affirm.

After being with Mr. Douglas a year or so, he was assumed as a partner, and he soon achieved for himself a position which, till his death, was ever increasing in importance. "There was no falling back, his name became familiar in our mouths as household words; he was spoken of everywhere; his works were spoken of, not only here, but in London." He crowded into the few years he lived the work of a long and busy life. The capacity of taking trouble Mr. Sellars had in a high degree; in his buildings there was nothing too small to receive attention; from the careful planning of the general structure down to the minor fittings—all were designed and arranged with equal care. When many a one, worried as *he* must have been with the numerous calls on his time and brain, would have saved himself by selecting articles already made, he rarely sought this relief; all must be in harmony, each article appropriate to its surroundings, and he thought no time misspent if this object were attained. When the pressure of work was great, and his time at the office too much broken in upon, he worked at home, where he had a room fitted up for the purpose, and where he could in peace and quiet mature his ideas, and overtake the demands of business. Along with the capacity for work was united a thorough knowledge of form, and a keen perception of the beautiful. Instinctively he seemed to select the best, and his power as a draughtsman enabled him, with comparative ease, to produce it with his pencil or brush. Accompanying these qualities, he had what is rarely joined to them, great administrative capacity: he could not only design, but could weigh the cost and restrain his pencil when necessary. In designing, all styles seem to have been alike to him; and when for the time he adopted a particular style, he was quite at home in it. Is it Gothic? take his Hillhead and Queen's Park Established Churches. His Greek is pure and sweet, as exemplified in St. Andrew's Halls and Anderston Free Church. The Renaissance is shown in the New Club, the Amicable Insurance Society Buildings, and the *Herald* Office; and one would have thought his life-study had been Moorish from the magnificent example in the Exhibition Buildings. The same thoroughness of work, even in the most trifling details, is shown in the interior as in the exterior of his buildings; all is in harmony, everything is complete; and all through his career he was constant in his efforts to improve his work.

He died in the height of his renown, when he had completed the International Exhibition Buildings, which, though erected of the commonest of materials, displayed all that care in the design, beauty of form, and arrangement that could have been attained in materials of a more lasting nature.

Most architects who have risen to eminence have been prepared for their work by a long course of special training, especially by travel, their mind quickened and their eye trained to a perception of the beautiful. With the exception of an excursion to Venice some years ago, Mr. Sellars never travelled abroad. When young, he had not the means; when able, no time; and yet in his knowledge of art, ancient and modern, few can be said to excel him. As to works that were old, he used to confess that their age was to him no excellence unless they were true and beautiful.

Filled with a love of his profession, he was keenly sensitive to any disapproval, and disparaging remarks regarding it did not fail to rouse his indignation. On such occasions he did not hesitate to express his feelings, for like most men of strong understanding, he had great strength of character, strong convictions, and no hesitation in expressing them, and that with a fluency and vigour which usually silenced such criticism.

The works carried out by Mr. Sellars and his partner, Mr. Douglas, were numerous and important. Permit me to mention a few of them:—St. Andrew's Halls, New Club, *Glasgow Herald* Offices, Amicable Insurance Office buildings, City Bank, Children's Hospital and Children's Hospital Dispensary, Hillhead and Queen's Park Established Churches, St. Enoch, Finnieston, and Finnieston Free Churches, Belhaven U.P. Church, the Town Halls [illegible] as would encourage private individuals or a company to solve the problem." At the end of his term of office he again became a member of Council, and continued so till his death. He was President of the Institute of Architects, Deacon of the Incorporation of Wrights, a liner in the Dean of Guild Court, and Honorary President of the Architectural Society—a society of young men connected with the profession. Of the last-named society he was particularly fond, and the present Honorary President, in his remarks to the members, lately said:—"To Mr. Sellars this Association is much indebted, and you know better than I can tell you the kindly interest he took in it. The lectures which he gave in several sessions, while free from rhetorical artifice, were elegant and appropriate in diction, and always characterised by great common-sense. They were eminently practical, conveying in easily understood language good advice and valuable information. They were the papers of an experienced man of business as well as of an accomplished architect. His name is on the syllabus of the present session, and we know not how much we have lost, now that the busy brain is at rest and the tongue for ever silent."

There is something inexpressibly sad in the thought that in the prime of life, while seemingly approaching the zenith of his fame, while there was much to hope from a man of his enthusiastic temperament, his indomitable industry and perseverance, his varied abilities both in the artistic and the practical parts of his profession, he should be mysteriously stricken down and removed, that in vaulting towards the topmost round of the ladder he should be thrown back for ever.

We have thus seen that he filled, and with honour, all the highest offices open to the architect in this city. It is, however, principally in connection with his work of the Glasgow International Exhibition that public attention has been drawn to him. Architects, as a rule, devote most of their attention to work for individuals; but it was Mr. Sellars' fortune to be connected with a structure that obtained world-wide celebrity, and that celebrity was to a large extent due to the Architect. Other towns have had exhibitions which may have rivalled if they did not surpass ours in exhibits, but none which combined this feature with a structure of great beauty and with surroundings arranged in perfect harmony. The idea of a Moorish building in prosaic Glasgow!—and yet with what skill the whole buildings were arranged to fit the site, convincing one that it was the only style that should have been adopted.

Mr. James Barr, C.E., the coadjutor of Mr. Sellars in the erection of the Exhibition, tells me that from January till March, 1887, the preparation of the competitive plans for the Glasgow International Exhibition absorbed his energies, which, impelled by enthusiasm, seemed inexhaustible. Twenty-two hours' arduous and unremitting toil was no unusual event in the flush of his ardour to attain success, and that explains the strain to which he subjected mind and body. Imperfection was to him obnoxious, and every detail he manipulated with care and thought till satisfied with the delineation of his conception.

At the end of March he was somewhat disheartened at the indication by the adjudicators upon the competing plans that he was not likely to be successful. The originality and novelty of his design had not been fully appreciated: the simplicity and suitability of the plan: the attraction to be derived by the treatment in colour—all these points required to be adequately grasped by closer study. But a resumed consideration of the efforts of the competitors proclaimed him victor. Gratified by this award, he threw himself with unabated vigour into the preparation of the working drawings, the framing of the specifications, and the arrangement of the contracts. The subsequent sweetness with which the work was completed and the accounts adjusted testifies to his unceasing assiduity, forethought, and great administrative capability, in carrying out with such rapidity, what became a gigantic work, in so limited a time. But it was well done, and without a murmur, either from the authorities or the contractors.

The ceremony of cutting the first sod was performed in May, but the architect found no rest till the middle of July, the period when the contracts were fixed. After a brief holiday he commenced the preparation of the special drawings, which, from the novelty of the design, his unique treatment of the simple materials to be used in the construction, and the temporary character of the buildings, entailed upon him enormous personal application, so as to secure cheapness without sacrificing effect. The object to be attained was to impart to light temporary buildings of great dimensions the appearance and impressiveness of a grandeur which might be imagined to last for ever. No minutiæ, artistic or constructive, would he adopt till its effect and suitability had been tested by every resource of his fertile fancy. Hence walls, domes, minarets, columns, panels, to be furnished in the least costly way, and in the slimmest form, consistent with the requirements and safety of the undertaking, entailed upon the architect more thought and labour than if his genius had been applied to the completion of a permanent structure. These temporary buildings covered an area of over ten acres, and when it is considered that their contract cost did not exceed twelve shillings per square yard, admiration for the ingenuity and ability of their architect is increased. Few, even of his professional brethren, can perfectly comprehend the study and research indispensable to embody in unison the various structures upon the grounds. Books, rare and reliable, were borrowed from known archæologists, old plans and designs were examined, and historical authorities consulted, before a line could be satisfactorily determined for the "Bishop's Palace," the *nom-de-plume* under which the plans were submitted in the competition. The universal approbation which its erection has won, as a contrasting feature of the Exhibition, is a worthy compliment to the versatility of the architect, who in all the change in form of the numerous buildings never omitted to let "order give each thing view."

His last great work was admired by all who saw it, and widely spread his fame. The spot chosen was worthy of the purpose. Mr. Sellars, harmonising his conceptions to the surroundings, transformed the scene into a witching panorama of oriental splendour. The sky-line was varied by the numerous dazzling turrets, minarets, and dome of the main building, the peculiarity of the colouring of which pleased and refreshed the eye, which, wander where it might, was gratified by the constant reproduction of the Moorish style in the kiosks and cafés which were dotted over the grounds. In striking contrast to all this was the quaint-looking Bishop's Palace, the whole forming a delightful combination which only an artist could produce. His work was appreciated, his success assured; both the press and the platform praised him. The commercial community vied in the multiplicity of forms in which they reproduced, and the purposes for which they used pictorial prints of the buildings. Special and high-class illustrations appeared in the leading journals at home and abroad. Hostile criticism was unknown. From the opening to the closing day the Exhibition in every department had an uninterrupted brilliant career of prosperity. But, short as that career was, sad is it to say that its close was not seen by its talented designer. The last week of what may be termed his business life was employed in revising the final accounts of the cost of the Exhibition. He felt relieved when on the 8th of September they were finished, and on the 4th of October a notice appeared in the newspapers that the accounts had been passed. But he was then weak, his strength was fast sinking. Hope was entertained by his family and friends that the gratification he derived from the accounts being confirmed would beneficially soothe him. But this cherished hope proved to be unfounded. On that day, in a room adjoining the one in which he lay, four eminent physicians were in earnest consultation on the gravity of his condition, which he had not fully realised. They resolved to tell him that his end was near. This sad announcement prostrated with grief his loving and devoted wife and his affectionate children. He died on the 9th of October, 1888, his strong constitution having fought with death a few days longer than was anticipated.

Mr. Sellars was a true man, a genial companion, a fond husband, and an affectionate father. He shone in his home, where his geniality brightened every face. His little speeches always said happily what was intended to be said. With his sweet sympathetic voice and fine taste and appreciation he sang some of our finest songs. He had a fine sense of humour and could admirably tell a story, and in his conversation he showed himself always well-acquainted with the passing topics of the time. As an architect his fame will be enduring, and future generations of citizens, who cannot feel the greatness of the loss which we have sustained, will speak of him with pride, and say, as they point to his works—"That's Sellars'."

IV.—*Rotifer as a Parasite or Tube-dweller.** By WILLIAM MILNE, M.A., B.Sc., F.R.S.E.

[Read before the Society, 19th December, 1888.]

(PLATE I.)

ONE evening about a year ago, when hurriedly examining some water with moss in it, I observed a Rotifer which might have been taken as a typical example of the genus which, in a former paper communicated to this Society (February, 1886), I named *Macrotrachela*, but it differed from every other species of the genus I had seen in having two red eye-spots well forward in the proboscis. I examined many other samples from the same water—taking great care of the moss, as the Rotifer I had seen was slightly bruised,—but without success, until somehow my attention was drawn to the moss itself, when I saw the same Rotifer snugly ensconced in the outer tube-cells of the branches of the moss. Having noticed this I had no difficulty in finding any number of specimens for examination, and I could also infer that the first one seen had been evicted from its dwelling by my having crushed the moss in placing it on the slide.

It occurred to me then that I had seen, somewhere in Pritchard's "Infusoria," a notice of *Rotifer vulgaris* as a parasite. On turning up Pritchard's book I found a reference to a paper by M. Morren in a volume of *Annals of Natural History* which I have not been able to consult. However, enough of extract is given in Pritchard's "Infusoria" (ed. 1861, pp. 466-7), for my purpose. The part that bears specially on the present paper is a statement by M. Morren of some most interesting observations made by Roeper. He says:—"The labours of Roeper show that the cells of Sphagnum are sometimes furnished with openings, which place their interior cavity in communication with the air or water in which they are immersed. This skilful observer satisfied himself that, when circumstances are favourable, the *Rotifer vulgaris*, one of the Infusoria whose organisation has been explained by the researches of Ehrenberg, exists in the cells of the *Sphagnum obtusifolium*. This grew in the air, in the middle

* Rotifer is here used as synonymous with the Bdelloida of Hudson and Gosse.

[illegible]

in the beginning of this [illegible]

Spinacium [illegible]

that of M. [illegible]

carefully examine the [illegible]

had been made of the [illegible]

mistaken for E. [illegible]

and all the more as up till now—and even in Hudson and Gosse's book—the presence of eye-spots in the proboscis in Bdelloida of necessity placed them in the genus Rotifer.

What is this animal, then, if not *Rotifer vulgaris?*

In the paper to which reference has already been made, I objected to the use of eye-spots as a generic distinction, and if I had known of this Rotiferon at the time it would have still further strengthened my objections. I gave a new species of what I then supposed and still believe to be Callidina, but with eye-spots, otherwise very like an older one discovered by H. Davis with no eye-spots, and which he called *Callidina vaga.* Hudson and Gosse having seen the latter, but not recognising it as a species of Callidina, had to institute a new family, Adinetadæ, for it, and would have to create a new genus for the newer one, as their generic characteristic of Adineta is—"eyes absent." They would have to place the subject of the present paper in genus Rotifer, and could not place it in their Callidina, generic characteristic, "eyes absent;" yet it plainly belongs to that genus, practically the same as the one I call Macrotrachela. Anyone placing it alongside any species of the genus Rotifer would notice the difference in general shape, even with *Rotifer macroceros,* which comes nearest in shape to Macrotrachela. But another very important point comes in to distinguish it still further. *Rotifer macroceros* is *viviparous,* and so are all the species of the genus Rotifer; this one is not, and I cannot recall a single species of Macrotrachela which is. This would form perhaps the best generic distinction.

As the animal is evidently the one seen by Roeper, I have called it *Macrotrachela Roeperi.* [Plate I., Figs. 1 (*a*), 2.]

Specific characteristics.—Body long and vermiform, the pre-intestinal part being about one-third, and the post-anal part about one-seventh of the whole length. The short proboscis bears two large and brilliant red eye-spots. The tactile tube is about three-fourths of the width of the neck at the point of attachment. The dental bulb is large and oval-shaped, and bears three teeth on each side. The foot is very short, the spurs one-half the breadth of ankle, and the toes, which are three in number, very short. The food churns round in the stomach in pellets in a way very characteristic of this genus. It is *non-viviparous.* Total length about $\frac{1}{70}$ inch.

Habitat, outer tubes of branches of Sphagnum.

[illegible]

Besides [illegible] there were [illegible] numerous other [illegible], but in no single instance was [illegible] found one inside the Sphagnum [illegible] save those [illegible] described as parasitic.

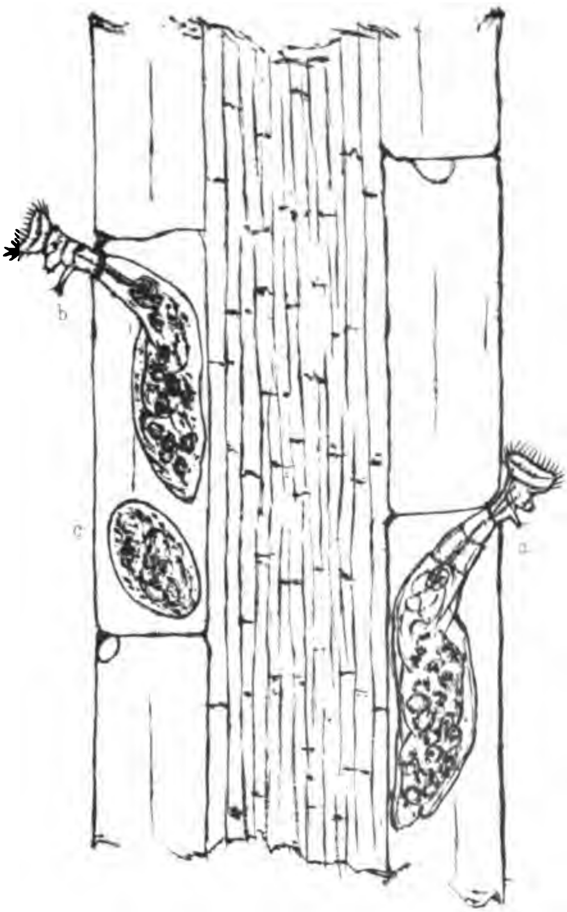
The stems, or rather the side branches of the Sphagnum have an outside row of large and colourless cells, with [illegible] openings to the exterior at their ends. Though they communicate with each other, according to Sachs, yet the opening between is apparently not so large as to allow of easy passage to the [illegible]. I have never seen any passing from cell to cell, and their actions when protruding the head to the exterior, and also when disturbed, led me to suppose that, practically, there was no free way from one cell to another for them. How, then, do the animals come to distribute themselves over the plants? They may be able to pass up through the stems by these interior openings, especially in the young stage, but I think the distribution is effected more through the exterior openings.

I have seen two adults and one egg in the same cell, probably two cells broken into one, the adults feeding from opposite ends; but evidently when the egg developed and the young began to assert itself, migration in some form had to take place, as there was no third opening, and no opening was large enough for two to pass from. Very possibly one of the adults, under the pressure from behind, would force itself out at the opening*—a very difficult process, as the opening is not much larger than the normal [illegible]

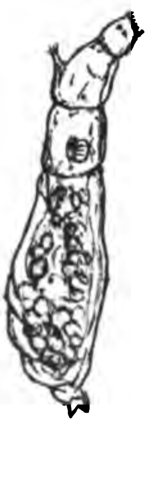
[illegible]

[illegible]

1



2



3

when growing; but whether they were there when the moss was pulled, or only entered subsequently, which would have been easy enough, as the whole moss was transmitted to me under water, I cannot say. I intend to investigate this when opportunity offers of visiting the locality where the moss grows; however, this is not so very important, as these cells carry water to the very top by capillarity.

The genus Macrotrachela seems to be the most erratic of all the Bdelloida. Besides the two species mentioned as being parasitic in vegetable growths, there is a third, *Callidina parasitica*, which, according to Giglioli, habitually attaches itself to *Gammarus pulex*. Another species (Fig. 3) inhabits tubes like those of Œcistes, but that this is habitual I do not pretend to say. Two examples were seen in a very few drops of water brought under examination, but of examining further the opportunity was lost. Of course several species of Bdelloida are to be seen at times with a large amount of loose material piled round them, brought thither by the action of their cilia, but in these cases there is no interior well-defined hollow, as was the case with the ones referred to.

It may be said that they had got by accident into tubes deserted by Œcistes. Very possibly, but then the visit was not a mere inquisitorial one, for in one of the tubes seen the animal had lying beside it two eggs, and seemed quite at home. Still, the eggs might have been deposited there by the original owner of the tube. To test this, one of the eggs was watched, and found to develop into a young Macrotrachela exactly like the adult. This might be taken as a fair proof that the Macrotrachela had inhabited the tube for a considerable time. It seemed to be a new species which had displayed this ingenuity, but unfortunately this could not be examined into at the time.

EXPLANATION OF PLATE.

Fig. 1. Section of Sphagnum with (*a*) *Macrotrachela Roeperi* feeding from an opening in cell; and (*b*) *Macrotrachela reclusa*; (*c*) undeveloped egg.

Fig. 2. *Macrotrachela Roeperi*, side view.

Fig. 3. Tube, probably deserted by a species of Œcistes, and inhabited by a species of Macrotrachela which has deposited two eggs.

V.—*The Eastman Stripping Film and Roller Slide: A Recent Development in Scientific Photography.* By William Lang, jun., F.C.S., President, Glasgow Photographic Association.

[Read before the Society, 7th November, 1888.]

In the various volumes which now constitute the *Proceedings* of the Philosophical Society of Glasgow there is, with the exception of a paper by Mr. John Urie on "An Automatic Printing Machine," read to the Society on 14th April, 1886, a complete absence of papers bearing on Photography. A reason for this may perhaps be found in the fact that there has been in Glasgow since the year 1854 a society devoting itself exclusively to photographic science; and photographic communications would naturally be given to the world through that particular channel. Photography, however, has not only made great strides within these recent years, but, a science itself, it has been rendering valuable service to the various other sciences. We find it assisting the astronomer in the mapping of the heavens. In the work done by the aid of the microscope, in the study of meteorology, in spectrum analysis, and in many other kindred sciences, it has been a veritable handmaid. That being so, any advancements that may take place in the apparatus, in the processes, or in the applications of Photography should not be without interest to the members of the Philosophical Society of Glasgow.

The two things which I would wish to bring more especially under your notice this evening are the Eastman Stripping Film and the Eastman Roller Slide.

A paper negative is in no way a new thing in Photography: it is as old as Photography itself. Fox Talbot's process, to which the inventor gave the name of *calotype*, and which he announced in 1841, was essentially a paper process. Calotype, or, to give it the name by which perhaps it is more generally known, *Talbotype*, was by no means a rapid process; in point of speed it had to give way to the more rapid collodion process, and this, in turn, has been superseded by the highly-sensitive gelatine plate of the present day. With collodion and with gelatine, the support was no longer paper, but the more weighty and substantial article glass. Before proceeding further, however, it may not be without interest if I show you specimens of these early negatives. The half-dozen which you see here mounted in a frame, along with some thirty others which I have here loose, and which will be handed round for you to inspect, are said to have been produced by the illustrious Talbot himself.

I would also beg to call your attention to the pictures which you may see upon the wall, and which are taken from a work entitled "Sun Pictures in Scotland," and published by Talbot in 1845. This book, and the equally famous "Pencil of Nature," are the two first books illustrated by the silver print. The "Pencil of Nature" bears date 1844, and I am enabled, through the kindness of Mr. J. Traill Taylor, the editor of the *British Journal of Photography*, to show you a copy of the work, which, I need hardly say, is excessively rare. There are very few copies extant either of it or of the "Sun Pictures in Scotland." As you will see, many of the pictures are very much faded, but at that time the strengthening of the image and rendering it more permanent by means of a deposit of gold, was not thought of, or, at all events, was not practised. The printing of the sensitive paper receiving the positive image was, in the case of these early negatives, a somewhat slow process, and hence the expedient of waxing the paper negative was resorted to in order to render it less impervious to light. In addition to this, the grain of the paper interfered with definition, and this, perhaps, was the most inconvenient feature connected with the whole process. Perfect results were therefore unattainable. Now, what was the weak point in the early days of Photography was no less a defect when the rapid emulsion of these recent years came to be applied in the production of paper negatives. The problem to be solved consisted in the getting rid of the paper which formed the support of the negative. This has been arrived at in a very simple and, at the same time, effective way, by an American firm named "The Eastman Dry-Plate and Film Company," and forms the subject of the present communication. The paper, before being coated with the sensitive emulsion, receives a coating of ordinary gelatine, and this being freely soluble in hot water, enables the photographer, in a subsequent operation, to remove the paper which, all through, has acted as the support of the image. I purpose at the conclusion to strip one of these negatives which, for the purpose, has been laid down on a collodionised plate and submitted to a certain amount of pressure. In order to give the necessary support to the image-bearing film (which is of the very thinnest character, as you will see from the specimen produced herewith), it is requisite that what is known as a gelatine skin be laid down on the negative while it is in position on the glass plate and in a damp condition. On drying, the skin and the negative are found to be in close contact, and the whole can then be removed from the glass, which, before receiving its coat of collodion, has been rubbed with French chalk, so as to facilitate the stripping operation. The finished appearance of a film negative may be well ascertained from the specimens which have been furnished by the Eastman Company. Regarding the photographic operations known as *developing* and *fixing*, little need here be said. The development is carried out in the same manner as in the case of the ordinary dry-plate. I do not propose going into details, but it may be sufficient to note the fact that on account of the negative being viewed, when being developed, through the paper support, the image appears denser than it really is, and hence development ought to be pushed till it apppears as if it were being overdone. The developer recommended by the Eastman Company is what is known as the sulphite developer, and is made up as follows:—

No. 1.	No. 2.	No. 3.
Sulphite of Soda, - 6 oz.	Carbonate of Soda, ½ lb.	(Restrainer).
Water (distilled), 32 oz.	Water, - - 32 oz.	Potassium Bromide.
Pyrogallic Acid. - 1 oz.		Water, - - 6 oz.

1 oz. water.
1 oz. No. 1.
1 oz. No. 2.
20 minims No. 3.

This form of developer does not stain the film to the extent that "pyro" used without the sulphite would do; hence, for the reason just given—namely, being viewed through the paper, a better idea can be had of the true density of the negative. Not much washing between the development and fixing is required. On account of the solutions acting from both sides of the film, more rapid action is manifested than in the case of the ordinary dry-plate, where, of course, one side of the film is protected by the glass support.

In the operations connected with the development of a gelatine plate it is customary to have recourse to an alum bath, either on withdrawal from the developing solution or at the end of the fixing operation. The object of this application of an alum solution is to prevent what is known as frilling, that is to say, a tendency of the gelatine to leave its glass support. In the case of these stripping films, such a course would be fatal to the removal of the paper; and hence immersion in a solution of alum at any stage of the operations is to be carefully avoided. The reason of this is obvious: the application of alum to gelatine rendering it insoluble in hot water, the soluble gelatine on which the success of the stripping operation depends would thereby be rendered insoluble, and the paper would no longer be capable of being removed from the image-bearing film. The stripping of the negative does not require to be done immediately after the developing, fixing, and washing operations. The pictures when dry can be put away, and the stripping operation can be performed at any subsequent period.

A film negative has certain advantages over the ordinary glass negative, inasmuch as it is immaterial which side it is printed from. In certain photographic operations what is known as a *reversed negative* is frequently made use of. Such a negative is often required in carbon printing, and in the photo-mechanical processes. A film negative, therefore, can be used as a reversed negative by placing the side which originally had the paper attached to it next to the sensitive paper in the printing frame. In the case where only one surface has been collodionised, it is always easy to determine which is the side to place next the sensitive paper to give a correct picture. The smooth collodionised surface sufficiently indicates this. The Eastman Company recommend that both sides of the film be collodionised. Of course this must be done when the negative is on the glass and is thoroughly dry, and before it is stripped.

A word or two regarding the details of removing the paper may perhaps be necessary. The glass plate which receives the paper negative should be, say, for the size known as "whole plate"—8½ inches by 6½ inches—half-an-inch larger each way, in this case 9 inches by 7 inches. Before collodionising, the plate, after being well cleaned, has to be dusted over with French chalk. When the collodion has "set" it is washed under the tap till all greasy lines disappear, and is then immersed in a tray of water, coated side up; the negative having been duly wetted is placed on the plate, and both plate and negative are drawn out of the water. By careful application of the "squeegee" contact between the two surfaces is thoroughly established—the important point to pay attention to being the elimination of air bells, which can readily be ascertained by examining from the front. Some blotting paper is now placed on the negative, and the whole is allowed to remain under pressure for a period of from 20 minutes to half-an-hour, not more. The plate is next transferred to a tray of warm water, say, from 120° to 140° F., and in a very short time the paper by gently raising one of the corners will, if all goes well, readily peel away from the insoluble film beneath. It is here that the greatest difficulty has been experienced, but in practice I have found that if the water employed has been acidulated by means of hydrochloric acid (say, about ½ oz. acid to 1½ pints water), the stripping is a certain operation. The use of the hydrochloric acid has a beneficial action, inasmuch as it acts as a clearing solution, should there have been any staining in the development of the picture. The negative is now transferred to a tray, containing what is known as the "soaking solution," which is made up as follows:—

Ammonia, - - - -	¼ oz.
Glycerine, - - - -	½ oz.
Water, - - - -	64 oz.

A gelatine skin, rough side up, is now immersed in the tray, and allowed to soak about a minute, and the skin and negative are withdrawn from the tray and the two "squeegeed" into contact. The back of the hand is perhaps the best "squeegee" under the circumstances. The glass negative, with skin attached, is now set aside to dry, when it is cut round the edges and peeled off the glass in the manner already described, and which I intend demonstrating at the close of the paper. The object of the soaking solution, with the presence of the glycerine, is to prevent the skin from becoming brittle and hard when dry.

Having now described somewhat imperfectly the method employed in producing negatives by means of these stripping films, we next come to a consideration of the apparatus made use of in the securing of the negatives. The Eastman roller slide, a specimen of which I have here (see Figs. 1 and 2), may be described as an extra thick dark cell or slide. I should explain that the sensitive paper is issued in a continuous roll sufficient for 24 or 48 exposures. The spool or core on which this roll is wound is so arranged that it fits into the part designed in the slide to receive it. The paper is drawn over the front portion of the instrument, and made by suitable means to attach itself to the spool which receives the paper after it has received the light impressions. The winding of the paper from the one spool to the other is effected by means of the key, which is placed at the upper left hand of the instrument; and during the passage of the film an automatic device designates the limit of the various exposures. On the upper right hand of the slide an indicator shows distinctly when the film is in position for exposure, and the operator's attention is simultaneously arrested by the action of an audible alarm. As I have filled the slide here to-night with a roll of plain paper, the action of the various parts can readily be ascertained by a simple inspection. The arrangement you see here is a provision for the maintaining of the film under definite tension during any atmospheric changes. A slide filled with a spool having wound on it paper sufficient for 48 exposures, say of the whole-plate size, will not exceed 2½ lbs., while the necessary equipment for 48 exposures by the ordinary method, that is to say, the employment of the coated plate, would weigh somewhere about 50 lbs. The advantages here indicated are so great that they need not be enlarged upon. For the tourist or the scientific traveller the possession of such an apparatus, dispensing as it does with the dead-weight hitherto inseparable from the photographic outfit, will simply be invaluable. It may be urged that the use of these films necessitates more work and more care in the various operations; but it must be remembered that the work is suchth at it can be done at one's leisure, while the work out-of-doors is reduced to a minimum.

Fig. 1.

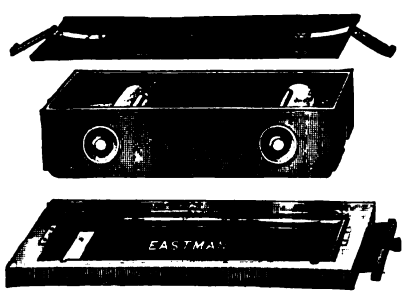


Fig. 2.

Fig. 1 represents the complete instrument, showing the winding key at the upper left hand, and the indicator and audible alarm at the upper right hand side.

Fig. 2 represents the instrument divided into three parts, the upper portion being the back removed from the central portion or case, in which are seen the rolls or spools of film in position. The lower part is the front with ebonite slide slightly drawn out.

Before I conclude I may be permitted to refer to another photographic novelty which has been brought forward by the Eastman Company, and in which the films we have been considering this evening are made use of. This is a detective camera, and has received the name of "Kodak." Through the kindness of the Eastman Company, a specimen is on the table (see Fig. 3), and notwithstanding the fact that it has been charged with the sensitive paper, it is open for the inspection of all. Sufficient paper is capable of being put into the instrument to meet the case of 100 exposures. The pictures secured by means of this instrument measure some 2½ inches in diameter, and are very suitable for showing in the optical lantern. The specimens furnished will indicate the nature of the pictures obtainable. For an equivalent number of

Fig. 3.

exposures, using the ordinary glass negative, the weight of the glass alone would be about 7 lbs. As I have to give a demonstration of the actual stripping of a film, and removing a film negative from the glass support, I shall now conclude this somewhat imperfect communication, and have only to add that I shall be glad to answer any questions that may be put by members, as I am afraid I have gone over the ground somewhat too hurriedly to have made myself properly understood.

The diagram herewith shows the mode in which the sensitive spools are inserted in the carrier slide of this "Kodak" camera. By means of the key shown at top of instrument, the paper is made to pass on to a winding spool. The circular opening represents the part where the image falls upon the paper. There is no audible alarm; instead, a visible indicator shows when the film is in position for exposure.

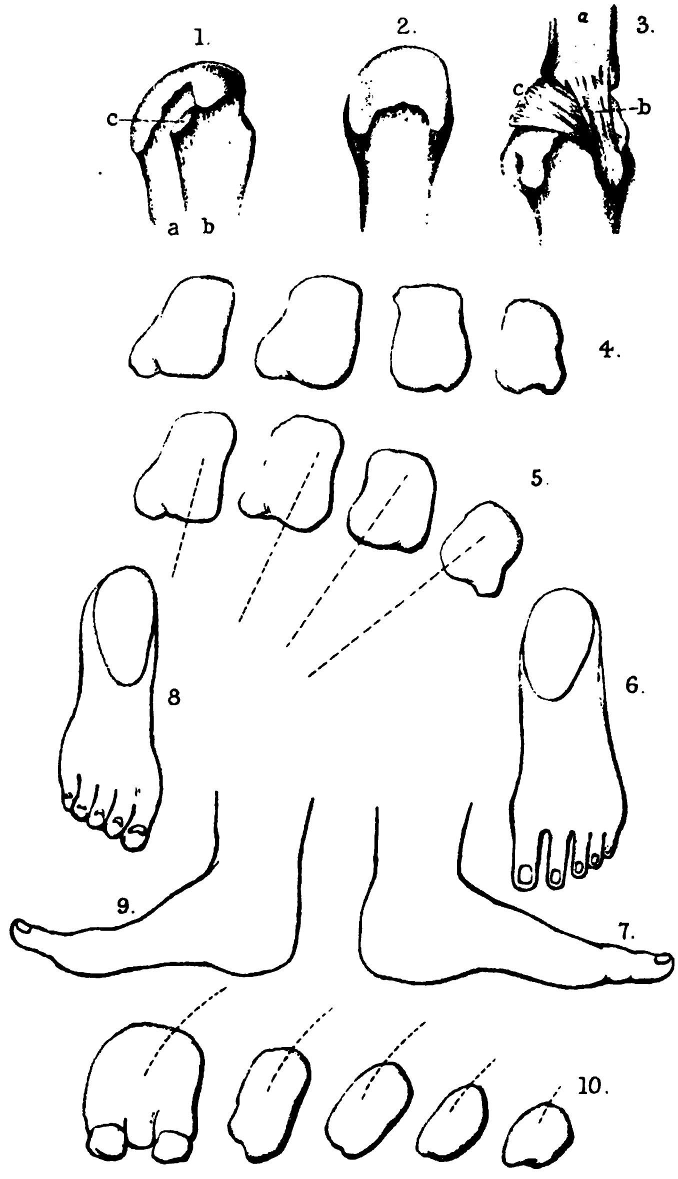
VI.—*The Movements of the Joints of the Knuckles and Balls of the Toes.* By Prof. Cleland, M.D., LL.D., F.R.S.

[Read before the Society, 19th December, 1888.]

(Plate II.)

The knuckles or distal ends of the metacarpal bones articulate each one with the first phalanx of its finger, and the articulation is a hinge-joint, with the bones kept together by lateral ligaments. But the peculiarity of the joints at the knuckles is that when the hand is open they admit of lateral movement by means of which the fingers are approached and separated, while when the fist is closed lateral movement is impossible. This result is accomplished by very simple means. The part of the surface of the knuckle which affords the path of movement for the phalanx from the straight to the completely bent position of the finger is elongated from dorsal to palmar edge, and the lateral ligaments are attached far back, so as to be considerably nearer to the end of the bone with which the phalanx is in contact in the straight state of the finger, than to the front of the articular surface on which the phalanx rests when the hand is closed. Also the knuckle is much broadened in front by the addition of a wedge of articular surface with which the opposite bone never comes in contact, but serving to stretch the lateral ligaments still more effectually when the hand is closed. It is the slackness of the lateral ligaments which allows the finger to be momentarily separated from the knuckle-bone when one pulls the finger and makes the joint crack. Elasticity is given to the extended joints when one has been leaning on the palms and then rises up, by there being ligamentous fibres which, arising in conjunction with the lateral ligament, pass forwards to be incorporated with the thick structure in front entering into the formation of the sheath of the flexor tendons and receiving the fibres of the transverse ligament stretched between the metacarpals. This arrangement does not seem to be generally known; but I find it constant, and it is obviously advantageous. In leaning on the open hand the ends of the metacarpal bones are pressed into a straight line, and the pressure, conveyed to the wrist, also tends to flatten its transverse arch; and from this flattening the hand recovers with considerable spring when the weight is removed from over it, so that in the ordinary position the row of knuckles is somewhat arched. But they are made to lie in the arc of a smaller circle when the fist is closed, and thus it happens that the tips of the bent fingers, there being then no lateral movement at the knuckle-joints, are pressed together towards the centre of the circle, and the closed hand made firm. This lessening of the circle in which the knuckles lie is effected by the simple expedient of the metacarpals of the ring and little fingers gliding on the bone which supports them at the wrist, so that when the long tendons which bend the fingers are pulled upon, they not only bend the phalanges, but drag forwards those two metacarpal bones.

The same transverse arching and flattening occur at the balls of the toes, and the joints there are constructed on the same principles as the joints of the knuckles. But the most interesting part of their movement is from the straight position on the flat ground to the over-extended position into which they are thrown when the heel is raised in walking, or when the points of the toes are raised, as by the forepart of the sole of a boot. Everyone knows that when the two feet are laid together on the flat ground, their inner borders ought to be parallel in their whole length; or, to put it more exactly, when they touch at the heels and the balls of the great toes, these toes ought to lie in contact in their whole length. In old statuary, one even sees the great toe inclined inwards, but that is apparently intended to denote the pressure at the base of the toe exercised by the strap of the sandal. Shoes are, however, made so that when placed side by side there is an angular interval between the great toes; and ever since the publication, many years ago, of Professor Meyer's pamphlet, "*Procrustes ante portas,*" there have been numbers of people who have thought this sufficient evidence that bootmakers distort the feet. Yet this is not really the case when the shoes are made to fit comfortably. A mocassin is made of such soft material as to adapt itself to the shape of the foot. Yet if worn for a while, it gets turned up at the toes, and the mark of the great toe shows an outward inclination, such as would be given to it by a shoemaker. The reason is not far to seek. If any one with the toes undistorted, so that the inner edges of the great toes continue forwards in a line with the inner edges of the feet, raises his toes from the ground by over-extension, his great toes will be seen separating and leaving an angular space between. The movement is a simple one, and can be appreciated at once by considering the extremities of the five metatarsal bones as one block. Then it will be seen that a line passing through them from the first to the fifth will lie in the axis of a cone, and that it is on the surface of this cone that the series of first phalanges revolve in the movement of over-extension. The path of movement can be read easily enough on the surfaces of the ends of the metatarsal bones, and it is the conical character of the movement which separates the toes of the two feet from one another. When the shoemaker turns upwards the point of the shoe he makes up for the outward inclination which he gives to the inner edge, and has merely followed the pattern made for him, not by mocassins only, but by the mould given to all thin flat slippers when they have been worn for a while. I own, therefore, that while I have often admired Professor Meyer's observations on joints, I have never been able to see the wisdom of his directions for reforming the shape of shoes. It has to be kept in mind that the wearing of shoes necessarily modifies the system of walking. In walking barefooted the great toe comes first to the ground, the weight being conducted outwards till all the balls of the toes are pressed on, and afterwards carried back in part for a moment to the heel, to be again thrown forwards and rested on the great toe before the foot leaves the ground. Also the foot has its transverse and longitudinal arches both materially flattened out by the weight of the body, so that it is continually changing its length and breadth. But with a thick-soled boot the toes are never brought first to the ground, except when the body is bent much forwards, as in running; and the arches of the foot are made somewhat less yielding by the support given them. In exchange for the protection of the boot, we put up with a limitation of the elastic movements of the foot; and that we are not mistaken in doing so is proved by the fact that all pedestrians prefer a thick unyielding boot for prolonged walking, notwithstanding the weight. The foot is then moved in a block. A position has to be chosen in which the foot is to be confined, and that no one could tolerate soles flat with the ground is shown by the circumstance that the toes are turned up even in wooden clogs.


1.
c
a b
2.
a
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b
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8
6.
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10.

EXPLANATION OF PLATE.

1. Knuckle or end of metacarpal bone of the middle finger of the left hand: (*a*) inner surface; (*b*) posterior surface; (*c*) surface of origin of the lateral ligament.
2. The same metacarpal bone seen from the front, showing how the articular surface is broadened by a wedge-like addition.
3. The same metacarpal bone: (*a*) portion of the first phalanx or finger-bone; (*b*) lateral ligament; (*c*) fibres passing forwards in front of the lateral ligament to support the joint in extension by being similarly attached at the other side.
4. The knuckles of the left hand as disposed in full extension of the fingers.
5. The knuckles of the left hand as disposed when the fist is closed. The dotted lines show the convergent directions of the fingers when bent.
6. Left foot seen from above when laid on the flat ground.
7. The same from the inside.
8. Right foot seen from above when the toes are turned upwards.
9. The same from the inside.
10. The ends of the metatarsal bones of the left foot, with dotted lines to show the paths of movement of the toes when they are turned upwards.

VII.—*The Training of Architects.* By HENRY DYER, C.E., M.A., Vice-President, Institution of Engineers and Shipbuilders, Scotland; Life Governor, Glasgow and West of Scotland Technical College.

[Read before the Architectural Section of the Society, 4th February, 1889.]

IT may seem strange that one who is not an architect should address a company composed chiefly of architects on the training which is necessary for their profession. I hope I shall be acquitted of all presumption when I say that I am here by invitation, and that my remarks are intended to be, to a large extent, supplementary to the excellent paper read here last session by Mr. Newbery. I suppose that the reason why I received the invitation was because for a good many years I have taken considerable interest in educational subjects, and have observed what is being done in the chief schools in different parts of the world for professional training; and also because I have taken an active part in the organisation of two Colleges on opposite sides of the globe, and under very different conditions, in which a course of training for architects forms part of the curriculum. I have thus found it necessary to study the opinions of architects, and what I say to-night will be in some parts a digest of those opinions, and in others I will quote them *verbatim*. I may, however, have occasion to say some things on my own account with which you do not agree, but in inviting me here I am sure you had no wish to restrict my liberty of expression, and it will at least do you no harm to know what some of the public think of the work of architects.

The invitation which I received asked me to speak on the technical training of architects. Now it may surprise some of you to learn that there is no phrase I dislike more than "technical training" or "technical education," and if I use it at all it is simply to prevent myself from being misunderstood by those whom I am addressing. A great many of those who speak and write about technical education, and also, I am sorry to say, many of the teachers who take part in it, seem to look upon the scholars merely as ambidextrous monkeys, or clever tools for turning out machines or manufactured products, and not as men made in God's own image. It is altogether a mistake to draw strict lines of division between the different parts of a man's education. A man ought to be trained intellectually, physically, and morally to perform the duties which are likely to fall to his lot, but the whole system should form something like a harmonious unity, and the result should be in the first place a man, and in the second an architect, an engineer, or anything else; and the chief use of that part of education which is generally called technical should be to give him the moral dignity and intellectual force arising from a correct knowledge of the principles of the work on which he is engaged. The complete treatment of the training of architects would therefore, in the sense in which I have used the term, involve the review of the whole question of education, which, of course, is clearly beyond my power in the time at my disposal. I will therefore dwell on that part which is usually called technical, and merely indicate its relations to the more general subjects. On the side of art I cannot do better than refer to the paper by Mr. Newbery, already mentioned. If I have any criticism to make on that paper it is that the author, like all enthusiasts, has so magnified the importance of art as almost to exclude all other aspects of the subject.

Mr. Newbery began his paper with a quotation from Ruskin—"To build is by common understanding to put together and adjust the several pieces of any edifice or receptacle of a considerable size, and building does not become architecture merely by the stability of what it erects. Architecture is the art which so disposes and adorns the edifices raised by man, for whatsoever uses, that the sight of them contributes to his mental health, power, and pleasure." Mr. Newbery remarks that Ruskin here makes a sharp division between building, as such, and architecture, which may be co-existent with it, and adds a corollary, "if, as goes in the saying, the architect be the artist, then in common with him he is divisible, so to speak, into two men—the designer whose brain conceives, and the workman whose hands execute."

I think Ruskin's definition is incomplete. It is not sufficient that an architect should "so dispose and adorn the edifices raised by man, for whatsoever uses, that the sight of them contributes to his mental health, power, and pleasure." In my opinion, the first duty of an architect is to make a building suitable for the purposes for which it is intended, and having done that then to make it as beautiful as circumstances will admit. Some structures are only intended to be looked at, and in those cases the architect may for the most part confine his efforts to what contributes to mental health, power, and pleasure. But the majority of structures are intended for living in, either as places of residence, or of occasional meetings, and if they are so arranged that bodily health suffers, "mental health, power, and pleasure" are not likely to be in good condition. It would be absurd to expect the architect to work out all details with his own hands, but he ought to know how they should be done, if he does not wish to become a mere decorator of the work of the carpenter, the builder, and the sanitary engineer.

In a recent paper Mr. Walter Crane, writing of the artist in olden times, said that he was "originally one with the constructive workman, the builder, the smith, the carver, the potter; he put the touch of art on his work in refining play of line and pattern, and he saw that it was good, with the pleasure and delight of a craftsman. So use and beauty were one in the old, simple days. But we have changed all that. We have put use in one pigeon-hole and beauty in another, and it is only by accident that they get mixed." As with art, so with architecture—use and beauty are often to be found in different pigeon-holes, and they seldom get mixed. The complicated requirements of modern civilisation demand that the architect should not only be an artist, but should also have a considerable knowledge of the engineering of architecture, of physics, chemistry, and geology, of carpentry and joinery, and of the practice of building. With a proper system of education, this could easily be obtained without putting a very heavy load on the shoulders of the students. In the days when our greatest churches and cathedrals were erected, the artisans or builders were also architects. In his recent book on "The Economic Interpretation of History," Professor Thorold Rogers, speaking of the architectural work of the middle ages, says—"The greater part of the handsome churches and conventual buildings of that age were the work of the artisans themselves, 'who could draw their own plot.' It needed no common or brief training to enable the mason to himself design these structures from the foundation to the roof, and then resign his work to an equally skilled carpenter. These working men were the teachers, the models of those architects who copy their labours in our days, and very often make a sad bungle of the imitation. In a time when men could not be spared for the otiose function of a designer, who very often knows little or nothing of the materials with which he has to deal, but the design came from the artisan, we may depend on it that a seven years' apprenticeship was no long period for the youth to learn his craft in, and become the rival in the new style of those great builders who had raised the structures of a previous century."

Sir Gilbert Scott in one of his earliest works made the following remarks :*—"Architecture differs from her sister arts of painting and sculpture in this, that while they directly originate from a feeling for beauty, and are either wholly independent of utility, or only accidentally connected with it, architecture results in the first instance from necessity, beauty being a *superadded* grace. The element of beauty may increase in its relative importance with the nature and objects of the building in proportion as the building becomes more monumental in its character; but in no class of building can beauty consistently be permitted to interfere in any degree with the efficiency with which the structure provides for and carries out the primary object of its erection, whatever that may chance to be.

"No class of building is so completely the result of necessity as our houses—our existence is dependent upon them, and health, comfort, and convenience require that they should be constructed with all possible regard to the demands of our nature and the customs and necessities of the state of society in which we are placed. We may superadd taste to any extent, but if it interferes with any of these primary requirements it (just so far) defeats the objects for which domestic buildings are erected, and becomes a nuisance instead of a luxury. It follows that no style of architecture is good for anything which demands that utility should in any degree be sacrificed to taste. It has consequently been in all ages the aim of good architecture not only to add beauty to utility, but, so far as possible, to make it *grow out of* and result from the uses and construction of the various parts of the building—an object which becomes doubly urgent in those buildings on which our life, health, happiness, and convenience are in so great a degree dependent."

With an opinion such as this, coming from a man like Sir Gilbert Scott, architects need not be surprised if a long-suffering public now begins to demand that they should qualify themselves

* "Secular and Domestic Architecture," p. 19.

to meet the conditions laid down in the sentences I have quoted, not only in our private dwelling-houses, but also in our public buildings, and that questions of acoustics, ventilation, and sanitation generally should be considered alongside those of use and beauty.

Architects very often complain that they are interfered with in the design of their work, and no doubt many who employ them are very unreasonable in their demands and impracticable in their methods of putting them; but it is quite impossible even for the best trained architects to design many buildings in all their details without receiving a considerable amount of assistance and advice. Even with what should be sufficient in both these respects, we find few public buildings which are what they ought to be in the matters of arrangements and internal fittings. One of the latest works of Sir Gilbert Scott, the buildings of the University of Glasgow, show that it is much easier to preach than to practice. There are some grand pieces of architecture about them, but in my opinion the front is too low to be in keeping with the general design, while in many respects the internal arrangements are very defective. I was a student at the University when the new buildings were opened, and I was much struck with the many examples of defective design which were to be observed. I will not enter into details of these, but the following observations by Dr. Dickson, the Curator of the University Library, may be taken as a sample of what might be said about the whole of the buildings. Dr. Dickson states that "the memorandum prepared for the building committee and the architect stated, *inter alia*, that the new library 'should be isolated as far as possible, so as to diminish the risk of fire, and constructed throughout with special precautions against that risk.' The building is not isolated, but has class-rooms and a dwelling-house attached to it, and, while concreted floors are provided by way of precaution against fire, an open shaft containing a wooden staircase passes up from the basement to the second floor of the main building. We asked that the building 'should be heated with hot-water pipes and well ventilated.' It was heated at first by hot-air flues (carried along, at least on the north side, beneath the basement) which brought in the dust and sooty smoke of Glasgow, as well as occasionally moisture, evaporated from water in the underground chambers—evils which became so seriously injurious that it was found necessary some years ago to supersede the system by that of hot-water pipes. We suggested, as regards the ground floor, that 'access to the upper shelves should be provided by means of light iron galleries;' but there are no iron galleries, and a large portion of the space for the storage of books is left wholly unoccupied under circumstances which make it difficult now to utilise it. We asked that 'if any considerable portion of the books should be placed in an upper storey there should be hoists for conveying them up and down.' But no hoist is provided even in the shaft intended for it. We suggested 'that a working room should be placed in close vicinity to the lobby for the delivery of books:' it was placed at the opposite end of the hall. We suggested 'a reading-room with abundance of light;' that which was provided was lighted only from one end, and it was necessary during a great part of the winter to use gas, which tended to vitiate the air of the room. We recommended that 'the cases should be uniform in size or disposed in uniform series, so that the books may be readily moved from one case to another.' On the cases for the ground floor arriving (at a time when the books were already in waiting for them) we found that the possibility of shifting the books in the room from case to case was precluded by a difference of some few inches in the height of the alternate cases."

For some of these things possibly the architect was not to blame, but such a state of affairs proves two things. First, that an architect should never become a manufacturer—that is, say, he should never undertake work which he cannot personally superintend, and for which he cannot be responsible. If he does, he sells his name as an architect for less than a mess of pottage, and no true artist will ever do that. In the second place, it shows how necessary it is that drawings and specifications should be as complete as possible, and the whole of the conditions carefully studied before the buildings are commenced. The difficulties which arise between architects and their employers regarding charges for extras are notorious. In many cases no doubt the latter are to blame for not having a clear idea of what they want, as their notions only begin to take shape as the building progresses, and the consequent changes allow opportunities for charging at higher rates, of which few contractors fail to take advantage. In any case the want of carefully-prepared drawings and specifications leads to a great waste of time and a large amount of worry, which are quite a sufficient justification of the demand that such work should form a very important part in the training of architects.

It is quite impossible to draw exact dividing lines between the work of the civil engineer, the builder, and the architect. If we adhered strictly to Ruskin's definition of architecture, and only gave the title of architect to those who designed buildings the sight of which contributes to the mental health, power, and pleasure of man, and then took a walk through our towns and cities to select by their works the men who were deserving of the title, we would return with a very short list. Nine-tenths of the buildings we see are simply specimens of civil engineering construction, in which we look in vain for anything approaching beauty. Their designers are very often not to blame for this, as they have been hampered by want of money or other circumstances. And yet want of money is not always an excuse for an ugly building. In Japan, for instance, the poorest building (if in Japanese style) has always something artistic about it. You may wander about the streets of a Japanese town for days and always come across something new which delights you by its beauty and arrangement. In most of the large towns in Britain, especially in those of recent origin, such a walk generally produces feelings of intense disgust. The west end abounds with monuments to vulgar ostentation, and the east with evidences of the degradation resulting from the hunt for wealth, and merely sensual pleasures.

In Germany, and especially in Prussia, the professions of civil engineering and architecture are united, and the same training is given to all the members; and it is only after men have displayed considerable ability and originality that they keep to a special province of their profession, and all who raise themselves above a position of mediocrity are either architects or civil engineers. In Japan, I insisted on all our students of civil engineering knowing sufficient of what is usually called architecture to enable them to design and construct such buildings as were likely to be required in connection with the civil engineering works on which they were engaged; and I think that every civil engineer ought to be able to do this. On the other hand, I insisted on all our students of architecture knowing sufficient of the principles of construction, and of the scientific arrangements of buildings as to enable them to make them stable and strong, healthy to live in, and otherwise suitable for the purposes for which they were intended. Although it is impossible to distinguish clearly between civil engineering and architecture, such an arrangement as I have indicated would lead to a very natural division. In certain special structures it might be necessary for the civil engineer to call in the aid of the architect, or for the architect to call in the aid of the civil engineer, but generally speaking they would be independent. On the other hand, the builder is necessary to both: he carries out their plans, and should in both cases be their subordinate. I have met civil engineers and architects who, from their ignorance of building construction, were largely in the hands of their foremen masons or carpenters. In country districts we very often find combined in one man the offices of civil engineer, architect, surveyor, and builder, and for the classes of work they are expected to do there are no reasons why this should not be allowed to continue. Attempts to arrange such businesses strictly according to logic, with the omission of common-sense, would lead to great inconvenience, and in many cases to very absurd arrangements.

In a recent magazine article* on the work of architects, the following opinions were expressed:—"The word *architecture* is more or less loosely used, and is taken by some to mean no more than the arrangement and supervision of buildings, with purely practical objects in view. There is a considerable proportion of building work which aims at no more than the purely utilitarian. The erection of warehouses, prisons, and many buildings of a similar nature is all comprehended in the popular idea of architecture; and in works of this nature, as a general rule, anything beyond the purely practical is neither desired nor aimed at. I do not say that the conditions under which such works are done necessarily preclude the possibility of an æsthetic effect. I should be loth to admit that any kind of legitimate building could not be made to lend itself to artistic purposes; but merely to assert that the practice is against any such ambition, and that those who undertake such operations are in loose popular terminology ranked as architects no less than those with whom the interests of art are altogether paramount." The writer goes on to say,—"For the purposes of this paper, at any rate, I should wish to exclude from consideration not only the 'sweaters,' but also those with whom the artistic motive is altogether lacking. Let them have due recognition as 'master-builders,' or by whatever better name may be found for them; but let us not think of anything else than the development of building into a fine art. This, then, will give us

* By Basil Champneys, "*Time*," October, 1888, p. 385.

a reasonable idea of what an architect is, and what he has to do. His work must, first, be his own ; and, secondly, it must have an artistic motive. He has not only to do all that the so-called architect (really builder) has to do, but he has to handle it all in such a manner as to produce a real work of fine art. It is not as though the two kinds of so-called architects had different functions to perform, the one of the lower and the other of the higher kind : the one the work of skill and knowledge, the other of imagination and art. He who is really an architect according to my definition has to do all that the other, whom I have called the 'master-builder," has to do ; but, besides all this, he has to work out the whole with a predominant aim at an artistic result. He cannot in any degree set the one against the other ; he cannot condone inferior arrangement or faulty construction by producing beauty in appearance. The public insists, and insists rightly, on the practical before all things. Even if it did not, an adequate understanding of the conditions of his art would lead the true architect to base the result he aims at upon the practical, which, though he makes it subservient to a higher end, is still essential, and in its domain, paramount."

The whole article from which I have quoted is well worthy of careful study, and although there are some points in it which may be criticised, still it gives a very good idea of the professional view of the question. The last three sentences are, however, practically sufficient for my present purpose. If architects are willing to admit that the buildings they design should in the first place be well suited to the purposes for which they are intended, and that they themselves should be qualified to say when the work has been carried out in a proper manner, and further that it is their duty to make them as beautiful as those purposes and the money at their disposal will allow, I may leave the exact limits of the profession to be defined by the architects themselves. But they must remember that in all professions every grade of ability is to be met with, and that while aiming at a high standard for those at the head of the profession, arrangements should also be made to meet the wants of those in the lower stages. They must also remember that, if they wish to exclude from architecture all the work which might be done by an intelligent "master-builder," they will make their profession a very select one.

Let us consider shortly some of the things architects ought to know, or be able to do, so that we may suggest arrangements for them acquiring the necessary training. Although I have said that the first duty of an architect is to make his buildings suitable for the purposes for which they are intended, he ought to be more of an artist than a mere constructor, so that there may be some chance of his buildings being beautiful. The artistic side should therefore always predominate in the training of architects. Mr. Newbery dwelt so fully on that last session that I need not enter on it at present, although a little later on I will make a few remarks on its relations to the other subjects which must be taken up.

Architects should know sufficient mathematics to enable them to understand the principles of the construction of such buildings as fall within the range of ordinary practice. There is no necessity for much of their time being taken up with this part of the course. What is required is a clear perception of general principles, rather than an intimate acquaintance with details of methods, as a little practice and the study of standard works would soon enable them to design sufficiently exactly, without requiring to go into elaborate calculations. At the recent meeting of the Archæological Association I took occasion to ask several well-known architects how far they found it necessary to make calculations regarding the strength and stability of their buildings, and they without exception replied that they seldom or never made any such calculations—the proportions and sizes of the different parts of their buildings being determined almost entirely from experience and observation. Nevertheless they all recognised the necessity of architects knowing the general principles on which such experience was founded.

Architects should have a fairly good acquaintance with physics—at least with those parts which are connected with the acoustics, lighting, heating, and sanitary arrangements of buildings. There are few public buildings in which a speaker can address a large audience with any degree of comfort to himself or his audience, and fewer still in which the arrangements for ventilation are even passably good. The necessity for good fresh air seems never to dawn on many architects, even of high standing in their profession. A short time since, under the auspices of the North-Eastern Sanitary Inspection Association, Professor P. Phillips Bedson, Mr. T. W. Lovibond, and Mr. Walter Severn made an examination, chemical and bacteriological, of the atmosphere of twenty-six buildings in Newcastle-on-Tyne. These included three theatres and five other places of amusement, five places of worship, seven schools, and two courts, in addition to libraries, lecture rooms, workshops, and the wards of an infirmary. With regard to the results, the assize courts, where mechanical ventilation was employed, came out decidedly the best, the amount of carbonic acid gas after a crowded day being only 6·66 parts per 10,000. Such a report cannot always be given of our law courts. A short time since one of our local judges, whose duty it is to punish for overcrowding in the dwellings of the poor, informed me that the air of the room in which he gives judgment is very often as bad as that of some of the lowest slums. In the Newcastle experiments it was found that churches, if not absolutely the worst with regard to ventilation, are at any rate very nearly so, the amount of carbonic acid gas during service ranging from 16 to 32½ parts per 10,000. On the other hand, the bacteriological results are fairly good, on account, I suppose, of the weekly sweeping to which the churches are subjected. In schools the purity of the air varies with the class of the pupils—the better the latter the better the former—both the chemical and bacteriological analyses giving similar results. Of places of amusement the public halls are in some cases worse than the churches, and in others better, whilst theatres proved in every instance to be better ventilated than churches. The researches of Professor Carnelly, and Drs. Haldane and Anderson, on "The Carbonic Acid, Organic Matter, and Micro-organisms in Air, more especially in Dwellings and Schools,"* should be carefully studied by all architects and sanitary officers, as they are not only models of what such researches should be, but they also show their bearings on the health of the population. I cannot discuss these in detail, beyond observing that, while carbonic acid gas and micro-organisms are not likely to do much harm to persons in perfect health, they may have a very bad effect on the feeble. Even when there is a slight catarrh, the bacteria are probably a source of considerable danger. The action of oxidisable organic substances in air is always bad, and has a very great effect in lowering the general health and predisposing to other diseases. The deaths from "debility" and "convulsions" in infants are perhaps in considerable proportions due to subacute poisoning by these substances. The results of such investigations, and the remedies their authors propose, are

* Phil. *Trans.*, Vol. 178 (1887).

now attracting the attention of architects, and sanitary science in its bearings on the profession, now frequently forms the subject of papers which appear in professional journals;* but we still want a more thorough system of instruction in our technical schools, so that young architects may look upon the subject as an essential part of their training, and not merely something to be picked up as chance opportunity offers.

Another subject which should receive more attention from architects than it does is the arrangements for the protection of buildings from fire, at least those which are necessary to prevent the spread of fire. Many buildings are little better than match boxes, and even in those in which special precautions have been taken we very often find some defect in construction or arrangement which practically nullifies all these precautions. The extension in the use of automatic sprinklers for the extinction of fire has thrown a considerable responsibility on the architect, for a little bad planning on his part may practically render them of no value.

It would be a great advantage if all architects could be got to serve a year or two at the actual work of carpentry or building, so that they might really understand how their designs were worked out. If this cannot be arranged they ought certainly to take every opportunity of making themselves acquainted with the methods of work, by inspecting buildings and visiting workshops. One of the writers from whom I have already quoted has said—"A faultless builder should have served his apprenticeship in each of the building trades before he attempts to supervise; and to realise this ideal we should have to make him undergo an education of say seventy years, at a moderate computation, before he was qualified to act. But seeing that the ancient standard of three-score years and ten does not fall far short of contemporary experience as to the duration of life, it is obvious that the builder must be content with something short of this degree of knowledge. His position, indeed, is not altogether dissimilar to that of the heads of our public departments, who, possibly in virtue of general administrative ability, make better superintendents of matters involving special and technical knowledge than those who have

* For example, see paper by E. C. Robins, "Royal Inst. of B.A., Nov., 1880." Reprinted in his book on "Technical School and College Buildings;" also an excellent book by Dr. Billings, "On Ventilation and Heating." Trübner & Co.

the technical knowledge and nothing else." The master-builder here described is really performing the duties expected of many architects, and unless these are content to become mere draughtsmen, who have to trust themselves in all matters of detail to the foremen builders, plumbers, and the host of specialists growing up around the profession of architecture, they must qualify themselves to superintend in an intelligent manner all the work done by the special practitioners.

Although I do not propose to enter into the details of the artistic training required by architects, I should like to say a few words on some of the relations of architecture to the sister arts of painting and sculpture. In the early days of art the painter looked upon the architect's walls as his legitimate field, while sculpture, especially in Gothic architecture, was even more closely related to architecture than to painting, and many of the most famous artists were distinguished in all the three arts. It is impossible to say, for instance, whether Giotto was greater as a painter or as an architect, or Michael Angelo as an architect, painter, or sculptor. Even when such men confined their manual skill to one department, the whole design was combined in one consistent, harmonious style. Now-a-days the architect seems to pay small attention to the work of the painter and the sculptor. The paintings may be good in themselves, and the sculpture all that can be wished, but they do not form a unity with the architecture. Those who have studied the details of the Houses of Parliament must have been struck with the incongruity of much that is to be seen. The paintings and the decorations have little or no relation to the architecture of the places in which they are found, and although of considerable merit individually, their general effect is bad. This is a subject which might be enlarged upon to a great extent, but I merely mention it to show the necessity for there being at least more sympathy between the architects, the painters, and the sculptors. If in these degenerate days we cannot find the three combined in one person, we have a right to expect sufficient artistic skill and critical knowledge of the other arts on the part of the architects as to prevent anything like discordance in the decoration of their buildings.

As I understand that the chief object in inviting me here to-night is to assist in arriving at a definite scheme of education for the young architects of Glasgow, I will now proceed to state the arrangements which I think ought to be made, and those which at present exist for affording them the necessary opportunities. We may have an ideal as to what we would like, or what ought to be, to which all our proposals should tend, but in the meantime we must content ourselves with what is possible.

As I have already indicated, it is highly necessary that in architecture, as in every other profession, the students should first of all receive as liberal an education as possible. By that I do not mean that they should necessarily be well up in classics and philosophy, for very often I find that men so trained are very far from being liberally educated. I attach more importance to the methods of teaching than to the subjects. Some of the latter ought, of course, to be of such a nature as to enable the students to rise out of the narrow groove which a strictly professional training is apt to give, while others ought to be scientific and lay the foundation for that training. Students of architecture generally belong to the middle classes, and remain at school till they are about 16 years of age, after which they enter upon a five years' apprenticeship. Hitherto they have to a large extent been allowed to pick up their professional knowledge as best they could, although in recent years the examinations of the Royal Institute of British Architects have done much to systematise study and to cause classes for instruction to be organised. These have generally been held in the evenings. In the Glasgow and West of Scotland Technical College, in conjunction with the School of Art and Haldane Academy, we have arranged courses of instruction in Building Construction and in Architecture which we trust will be found of use to builders and to architects, while the School Board has classes for Building Construction and Drawing. In the Technical College we have two grades of instruction and certificates, as we wish to encourage the students to go through a systematic course of instruction, and not merely to content themselves with those parts which seem to have an immediate application in their daily work. The Junior Course is comparatively simple, and should represent the minimum which every student should know of the theory of his subject. The Senior Course is intended for those who are above the average in ability and industry. To encourage students to take this Senior Course I would suggest that those apprentices who had completed it by the fourth year of their apprenticeship should be relieved of one year of apprenticeship.

The Courses for Building Construction are as follow:—

BUILDING CONSTRUCTION.

Year.	Subject.	Pass Required. Junior Certificate.	Pass Required. Senior Certificate.
I.	Practical Plane and Solid Geometry, -	1st Class, Elementary,	1st Class, Elementary.
,,	Mathematics, - -	1st Class, 1st Stage,	1st Class, 2nd Stage.
,,	Model Drawing, -	2nd Grade,	2nd Grade.
II.	Theoretical Mechanics,	1st Class, Elementary,	1st Class, Elementary.
,,	Applied Mechanics, -	————	1st Class, Elementary.
III.	Building Construction,	1st Class, Elementary,	1st Class, Elementary.
,,	Carpentry and Joinery,	————	2nd Class, Ordinary.
IV.	Building Construction,	————	1st Class, Advanced.
,,	Carpentry and Joinery, or	2nd Class, Ordinary,	2nd Class, Honours.
,,	Brickwork & Masonry, or		
,,	Plumbing, - -		

It will be observed that Art is entirely absent from these courses, as they are intended for builders, carpenters and joiners, and plumbers. We cannot arrange an indefinite number of special courses, and therefore for the first three years we have selected subjects which are useful to all engaged in the building trades, while the subjects of the fourth year are specialised. The certificates referred to in the "Pass required" are those of the Government Department of Science and Art, and of the City and Guilds of London Institute.

The Courses in Architecture are as follow:—

ARCHITECTURE.

YEAR.	SUBJECT.	PASS REQUIRED.	
		JUNIOR CERTIFICATE.	SENIOR CERTIFICATE.
I.	Mathematics, - -	1st Class, 1st Stage,	1st Class, 2nd Stage.
,,	Practical Plane and Solid Geometry, -	1st Class, Elementary,	2nd Class, Advanced.
,,	Model Drawing, -	2nd Grade.	2nd Grade.
,,	Perspective, - -	————	2nd Grade.
II.	Mathematics, - -	1st Class, 2nd Stage,	————
,,	Building Construction,	————	1st Class, Elementary.
,,	Theoretical Mechanics,	1st Class, Elementary,	1st Class, Elementary.
,,	Elementary Principles of Ornament, -	————	3rd Grade.
,,	Sciography, - -	3rd Grade,	3rd Grade.
,,	Drawing and Shading from Cast, - -	————	3rd Grade.
III.	Building Construction,	1st Class, Elementary,	1st Class, Advanced.
,,	Applied Mechanics, -	1st Class, Elementary,	2nd Class, Advanced.
,,	Perspective (Theory and Practice), -	————	3rd Grade.
,,	Modelling, - -	————	3rd Grade.
,,	Elementary Architecture, - - -	3rd Grade,	3rd Grade.
IV.	Building Construction,	1st Class, Advanced,	————
,,	Sound, Light, and Heat, - - -	1st Class, Elementary,	1st Class, Advanced.
,,	Architectural Construction, - -	3rd Grade,	3rd Grade.
,,	Drawing from Antique,	————	3rd Grade.

In these courses Art receives a large proportion of attention, while at the same time there is sufficient given to Science to enable the students to take an intelligent view of the various kinds of problems I have enumerated. The classes are conducted according to the methods and syllabuses of the Science and Art Department, and the City and Guilds of London Institute. As, however, the Governors of the College wish to encourage systematic teaching, and to discourage teaching which is chiefly directed to the passing of examinations, the students must not only pass the examinations enumerated in the courses named, but must also do the work of the classes in a satisfactory manner.

Between the Technical College and the School of Art we are able to completely carry out these evening courses of instruction, and I have no doubt they will be found sufficient for many of the students. But still we ought to have day classes as well, and a course of instruction in Architecture and the subjects connected with it is included among the other day courses of the College. We have made arrangements for all the subjects included in that course with the exception of architecture proper. The subjects of the first year are common to all the courses of the College and are as follow :—

FIRST YEAR—Natural Philosophy.
Mathematics.
Chemistry.
Drawing.
A Modern Language.

The subjects of the second and third years are—

SECOND YEAR—Freehand Drawing.
Applied Mechanics.
Drawing.
Architecture.
One General Subject
(*e.g.*, Literature, History).

THIRD YEAR—Architecture and Building Construction.
Drawing Office.

To the arrangements which are necessary for the completion of this course I wish to direct the special attention of the architects of Glasgow. I do not think it would be advisable to start with anything very elaborate. At the conference which was held in London nearly two years ago on the Education of Architects, Professor T. Roger Smith made a suggestion for a Studio for

Architecture which was very good, and which I think might be adopted in Glasgow with great advantage. This studio was not to be on the lines of the *ateliers* in which architects, painters, and sculptors in Paris learn their art, but with some resemblance thereto, though more like some private drawing studios, such as Leigh's, which have done good work in London at one time. The subjects to be taught ought to be those which the master is thoroughly competent to teach, and such as the students most require to learn. Professor Roger Smith suggests the following:—

1. Draughtsmanship.—Every drawing made should be scrutinised from the point of view of how it is done, as well as what it represents, and each day's work, as far as it is done with the pencil, should be a drawing lesson as well as an architectural lesson.

2. Architectural forms and details.—Professor Smith refers to his syllabus issued under the Science and Art Department for a synopsis of the subjects, although for advanced students he thinks the teacher should go in for original work, and as far as possible develop the special style in which he has won distinction.

3. Designing architecture, general principles of composition, consistency in the use of examples, and practice in making designs to conform to a fixed programme, and to embody the forms and details of a definite style.

4. Perspective and sciography.

5. Water-colour drawing.

6. Measuring, sketching, and drawing out portions of some existing building, and drawing up a written description of the same.

7. Descriptive geometry, and the modern graphic methods of investigating the strains in trusses, beams, arches, and other structures.

8. Building construction.

Professor Roger Smith remarks that if it were possible to combine with the studio a workshop where the students could do some carpenter's, joiner's, or mason's work, under a competent foreman, this would add to the value of the course.

He is of opinion that such a studio should attract at least three distinct classes—(1) Youths destined for the architectural profession who have left school or college, but whose friends are very wisely advised that they will be better prepared to reap benefit from being architects' pupils, if they have some instruction in the rudiments of architecture before being articled; (2) Pupils whose masters recognise that their offices are not places where such definite instruction is possible, and embrace an opportunity of such teaching outside; (3) Young men of older standing preparing for the Institute Examinations. He admits that it would be most difficult to find the right man to undertake the work, as the qualifications were numerous. He must be an educated and cultivated person, both as to general knowledge and as to architecture. If he is to teach and train, he must first know and be trained. He must also be apt to teach, and he must be thoroughly in touch with men, capable of feeling all a young man's difficulties, winning his confidence, and rousing his enthusiasm. A last qualification, but an essential one, if the experiment is to succeed, is that the master must be to some extent a man of mark, at least of sufficient standing to command the confidence of the students, of the body of architects, and to a certain extent of the outside public; otherwise students will be slow to find him, and their friends backward in sending them. Professor Roger Smith asks "Why should not a properly trained architect—or better, two friends, of whom one inclines to the art and the other to the science of his profession—open a large, well-lighted room, fitted like a drawing office, but with the addition of a good supply of the needful books, prints, and plaster-casts, where students could attend five days and a half in the week, and receive instruction, and draw under constant, or at least daily, guidance and supervision?"

In the Imperial College of Engineering, Japan, I arranged for a studio very similar to that suggested by Professor Roger Smith, and our Professor of Architecture—Mr. Conder—conducted the work very nearly on the lines he has indicated. But instead of being a separate studio it formed part of the college course, and the same method applied to every other subject. Mere college lectures are of little use; the instruction in every department of science or art should be made up of lectures, drawing office or studio work, and experimental work in the laboratory or workshop.

The question which I wish to ask is this—Are the architects of Glasgow sufficiently in earnest on the subject of their professional education to start such a studio as I have mentioned? It might either be in the buildings of the Technical College or of the School of Art, but it would be to a large extent under the direction of the architects themselves, who would appoint a certain number of visitors to assist the architect in charge. Some teachers are so very touchy about the dignity of their position, and have such a high opinion of their own methods, that they resent what they call the interference of such visitors, but when common-sense prevails, the arrangement is found to be of the greatest advantage. Such an arrangement exists at the Architectural School of the Royal Academy, and Mr. Spiers, the master, reports highly in its favour. He says, "It is needless to say that the arrangement has been productive of the greatest good; after many years of teaching there is a natural tendency to settle in a groove; it was not observable at the time, but now, as I look back on the old days when I was sole Director, I see I was running in a groove out of which I have been taken by the visitors, and I have probably learned more from their teaching than perhaps even the students."

The day courses for the Technical College extend over three years, and are supposed to begin when the students are 16 years of age, on the average. If we had the Architectural course completed in the way I have suggested, I have no doubt but that a good many after leaving school, instead of proceeding at once to an architect's office, would take the course of study at the College. Those who completed this and obtained the diploma, should, in my opinion, only be expected to serve a three years' apprenticeship, as I am sure that their College and studio course would be more than the equivalent of the other two years usually required. I have suggested that those who have obtained the Senior Certificate of the College should only be required to serve four years' apprenticeship. By the regulations of the College those who have obtained this certificate may, after a year's attendance at the day classes, also go in for the diploma. The year saved from their apprenticeship may be utilised for this purpose. I do not think it necessary to trouble you further with details of courses of study or of other arrangements, for these can easily be settled after the main lines of action have been laid down. The report of the Conference, convened almost two years ago by the Royal Institute of British Architects, gives a good synopsis of the practice in different parts of the globe and of the opinions of leading architects, from which little difficulty would be experienced in making a selection suitable to the circumstances of Glasgow.

I have said that in all our proposals we ought to have an ideal clearly in view, and in my opinion every educational arrangement should have for its crown a University degree. We hope before long that the Technical College will be connected with the University, and that its classes will be recognised for a great part of what is required for a degree. Whatever arrangements are made in this matter, the architects of Glasgow should not rest content until they have a Professor of Architecture in the University: a man of wide culture and experience, who would imbue architects with proper ideas of the dignity of their profession, and lead public opinion in such a way as to ensure that opportunities were afforded for the most thorough training being obtained by those who were really able to take advantage of it.

I have only one other piece of advice to give, and that is, do not increase the number of examinations unnecessarily. Let the architects be properly represented on the examining boards of the different teaching institutions, and let their certificates or diplomas be accepted by the professional Institutes. The tendency of the present day is to multiply examinations to such an extent as to stifle all originality on the part both of the teachers and the students, and to turn out the latter loaded with certificates, but with all true scientific or artistic spirit extinguished. I trust that the architects will show that they are in earnest in the matter of education, and will do all in their power to advance it, and induce their students to study the art and science of their profession in such a way as will not only make them good architects, but also, what is of more importance, good men.

VIII.—*Fisheries in Relation to General Civilisation and Progress.* By W. ANDERSON SMITH, Member of the Scottish Fishery Board.

[Read before the Society, 23rd January, 1889.]

IN the very earliest of human records, in the Palæolithic age itself, "the fisher baited his angle when the hunter twanged his bow." Indeed, one is inclined to suppose the fish-hook a prior invention to the bow and arrow, when we find it still employed by the most barbarous nations, of the rudest possible form, and of the simplest imaginable materials. It must have been easier for our prehistoric progenitors to sit and lure the fish from the stream than to follow the cave bear to its den, or to lie in wait for the hairy mammoth and the woolly rhinoceros.

I do not, however, intend to enter upon a discussion of the comparative antiquity of the hunter and the fisherman—a great Nimrod always figuring in antiquity as a more generally interesting person than he who plied the net or the hook and line. The chase being the "mimicry of noble war," and a school for the training of warriors, must have taken precedence of fishing, which would thus be relegated to an inferior class; and the "Annals of the Poor" have not been considered of any special interest until these latter years. When the hunting progressed into the pastoral age, and the wild ox gave place to the flocks and herds, Nimrod was as much an outcast as the Rocky Mountains trapper on the confines of the American settlements. But as its twin brother fell in public estimation, fishing must have advanced. As the occupied lands got cleared of wild animals, and game could only be looked upon as permitted trespassers by the owners of pastures, the rivers must still have offered rich opportunities for the required meal to the humbler hangers-on to budding civilisation. Somehow there would be a greater sense of stability about fishing to what attached itself to hunting. In the northern rivers of Europe and Asia, as in those of America to-day, the Salmonidæ would offer a regular and certain harvest to the dwellers on the banks. Not even the luxury of a fat buck or a wild heifer, we should think, would long blind self-indulgent humanity to the beauty of a salmon steak, or the savoury nature of sturgeon roe. Then they kept to their seasons with marvellous certainty, while no one could calculate on the reappearance of a herd of deer, or tell the whereabouts of a herd of wild asses. Fishing, indeed, was as great an advance upon hunting, in the direction of security and civilisation, as the "tribe" was an advance upon the "family." It is true that when fish were too plentiful and too readily obtained, a savage race might be still more degraded by it than by hunting, in which courage and ingenuity were constantly required. We see this to-day in the Indians who rely upon the Salmonidæ of the rivers on the Northern Pacific, and almost hybernate through the long winters on the readily-obtained products of their fish spears. Other intellectual races of savages seem never to have passed through the fishing stage, the Kaffirs and Zulus having apparently passed into the incipient stage of agriculture, through pasturing, without ever having dug out a canoe or launched a boat. It may have been the same with the early swarms that were thrown off from the Asiatic hive, and reached the West Coast without having lingered long enough by the Baltic, or the North Sea, to have developed those sea-roving instincts more especially characteristic of the Teutonic nations. No one who is acquainted with the old life of the "shielings" in the Highlands but must have been tempted to trace it back to the pastoral age, their agriculture being but a crude adjunct forced upon a pastoral people in an inhospitable clime. This may account in some degree for the extremely backward state of the fisheries in these islands, where all nature would otherwise naturally stimulate to a development of this industry.

The probability is, and language supports the supposition, that fishing took its origin in the inland waters of the East, the spear and the arrow being the first weapons of attack. From the barbed spear to the hook is but a short step, from fixing the spear by force to inserting it by treachery a mere modification. Some of the rude shark hooks of the Arctic Seas, with the barb formed from a bone or tooth, might well be the heads of spears, with the barb prolonged. Again, the "fowler's snare," that is represented in very early Egyptian sculpture and painting as a net spread for wild fowl on the back waters of the Nile or the Egyptian lakes, would naturally be employed in the waters alongside to catch the finny prey. From a wild duck to a *Silurus* requires little inventive faculty to stretch, when both frequent the same waters, and are caught by the same devices. The numberless constructions of basket-work, or wattled-work, or stakes that are still employed, as they have been from time immemorial in the Asiatic inland waters, are no doubt modifications of similar erections on land in early times; and it is not until we have followed the salmon down to the sea and lost it in the salt water, that the ingenuity, the courage, and the skill are developed that must attend a people that emerges from savagery into capable fishermen and seafarers.

The more obvious and natural methods of capturing fish in quantity apparently suggest themselves to all races, however widely apart and differently situated. They do not represent any very great stretch of intelligence and ingenuity, and only demand a little common sense in modifying the process to suit the particular locality. In Central Africa, as in Central England, "cruives" are erected for the wholesale capture of river fish, their presence in Africa by no means denoting former or present civilisation; although their presence in England reasonably suggests barbarism! Similarly, the Black Sea, the Mediterranean, and the Pacific, equally stretch out net-work from the shore to meet and capture or lead into traps the shoals of fish that pass shorewards. These are almost self-evident plans, and our own bag-nets are merely developments and modifications of the primitive arrangement.

So soon as we pass beyond savagery the age of stimulation of invention is reached, and we find that this industry has done very much to develop many dependent ones, as well as many not directly related to it. I will endeavour to explain a few of these, and indicate what we owe to the fisheries in this direction. So long as population continued moderate and fish were plentiful, no great endeavours were requisite. The great wars of the heroic age, when men preferred to die in harness rather than in their "poky," uncomfortable little bedrooms, kept people in a proper ratio to the attainable necessaries of life. Under these circumstances for ages no great advance was made in fishing, although in China great progress was made in the rearing and breeding of fish.

It is somewhat remarkable that in all ages and countries the fisherman has been looked upon as the typical poor man—not being a beggar. He does not require to be one of the Egyptian

Ichthyophagi, whose fishing implements were entirely of stone; or a Chinaman, with whom competition is rampant; or an Indian shivering in his hide tent through the long Canadian winter, and sucking dried salmon. Alike on the lovely shores of the Mediterranean and the desolate shores of Lewis, the fisherman has been proverbially poor. I do not think I ever read a tale of a fisherman who was not living a precarious hand-to-mouth existence.

It appears, then, that fishermen were originally to an extent life-failures on land, and driven to drag from an unfriendly element their daily bread, where, however, no man could reasonably claim ownership in early times. When the fish declined with thanks to enter the shore toils, or approach near enough for ordinary capture, the fisherman would be forced to go after them; and, no doubt, the necessity for this would be one of the earliest stimulants to the building or formation of boats. The dug-out canoe, or the hide of the slain ox stretched over wicker-work, would both be of the original style in different localities. But once we allow the hide coracle and the net, the further progress is not difficult to follow. The house-boats of Chinese rivers would naturally develop into the sea-going fishing junks, and the hives of China, as of Egypt, would be forced to make the most of their waters as pressure of population increased. The fact that a population of over a million-and-a-half are dependent upon fishing in Japan, and that they employ upwards of 187,000 boats of all sizes, points to fishing as stimulated by difficulty of obtaining animal food amongst a dense population. It takes long residence on the sea coast, and familiarity with the sea, ere a people become fishermen; and in all probability the fisherman was in early times, as now, the fore-runner of the seaman, and the fishing boat the precursor of the trading vessel.

Let us leave the early ages and come to more recent times, and we shall better be able to follow my general argument. Acknowledging that the fishermen as a class have been always poor, that they have been naturally the "drift" of a land population, and that they have probably been little interfered with by the successive waves of aggressors that have swept over every country at one time or another, we can better understand their character and position. Always somewhat isolated from the rest of the population, never rising to that state of independence necessary for cultivation and progress, they have remained commonly stationary, and owe every step in advance to the impetus of outsiders. Even in the case of new lands the fishing population remain as a body as unprogressive as the petty squatter. This seems remarkable in a calling in which many of the highest qualities of the human mind are called into operation. Skill, keen observation, courage and self-possession in the hour of danger, and infinite patience and self-control at all times, should naturally be expected to stimulate enterprise and invention. I never heard of fishermen inventing anything but an excuse, and their lack of enterprise seems to me inexplicable. But if not themselves fertile in resource, they have been the cause of invention in others. The extreme readiness with which fish decay, and the quantities which approach the centres of capture at one time, stirred up men to discover means by which to keep them wholesome over a period. The drying of fish for this purpose was no doubt discovered by many different tribes and peoples, and salt as an antiseptic comes from the earliest ages; and yet the salting of herring in barrels dates from quite recent times, and may be looked upon as the making of Scotland. Its importance can perhaps best be judged from the fact that a century ago carts travelled from the centre of Perthshire to Crinan, thence to take back a load of herring that were in a stinking condition long ere the rude vehicles could reach their destination, and yet, such was the state of our population at that time, that even this addition to their diet was welcome.

There is no doubt that the Dutch, amphibious as they were, showed us the way to our own marine wealth, and taught us how to make use of it. Indeed, the great struggles of this country with Holland and France are redolent of fish. Let us first look at Holland. Her annual revenue from her herring fishing vessels could not be computed at less than three million pounds sterling, and in one year she is said to have sold £4,795,000 worth of herring, besides what was consumed by themselves. Let us look at any old Dutch map and we shall see rude figures of her Dutch busses in all those seas where the herring fishing was important. They are dotted all over the inner waters of the Hebrides, and circled about the Orcades, until the persistent nursing of our fishing industry by means of bounties on the one side—and the valour of English seamen on the other—gradually transferred a large proportion of this trade to our own fishermen.

The fisheries have been to Holland a source of enormous wealth, if, perhaps, also the cause of her having been driven from place and power among the nations. If the cod and herring taken by the

Dutch to-day do not exceed the produce of the manufactures either of France or England, as they did in Raleigh's time, the fisheries have yet helped to provide all these nations with the capital for other and more notable enterprises. It has been calculated that Holland made more in a year by her fisheries than Sweden in twelve years by all her iron mines. This also, let it be clearly understood, was mainly from Scottish waters, where she employed a large proportion of the 12,000 vessels pertaining or attached to her herring fishing fleet.

If the history of Holland shows her prosperity to be built on fish scales, the history of France shows how tenaciously she has fought for fishing facilities. From the first discovery of Newfoundland it was looked upon merely as a great fishing centre. So much was this the case that the population were not allowed to remain upon it, and the governor left after the fishing season. Any who did remain were looked upon as outlaws; and the whole island was managed as if it were afloat, and the governor was captain of the vessel. The story of the struggle to keep France out of it, and yet not ourselves remain in it, is one of the most ludicrous and humiliating in the history of misgovernment, a story, strange to say, that is not yet over, as a portion of Newfoundland is at this present moment belonging neither to France nor England in any proper degree.

These Newfoundland fisheries have been worked for some centuries with undiminished success, and have been a powerful impetus to North American enterprise. From Newfoundland the Labrador Coast for 1,000 miles obtains its summer fishing population, and lands that might never, for their own sakes, have received a single colonist for centuries to come, are being brought into touch with civilisation by means of their wealth of fisheries. The same may be said of Alaska territory on the Pacific, and the Icelandic and Faroese waters of Europe. To Iceland, as to Newfoundland, the French send many vessels, well-manned and admirably-equipped, and from them can always draw a well-trained reserve for their navy.

It is unnecessary to point to the importance of the Canadian Fisheries, that have so often almost produced a conflict between ourselves and the States; or to the still more important fisheries of the North Sea, that are a source of constant rivalry between the bordering nations, and must sooner or later be adjudicated upon by an International Convention. As they are of immense value from their proximity to our markets, where the products can be disposed of fresh, we shall have to combat our competitors with that judgment and that diplomacy which were so markedly absent from our older efforts.

The large body of skilled foreign antagonists who have entered upon this great industry must force the civilised fisherman to leave aside his old prejudices, to forget his traditional ways, and to make use of all the improvements that modern science has brought to bear upon his art. The emulation of the fishing trade has evolved in Scotland boats of moderate tonnage, that are unrivalled for beauty of line and yacht-like grace of motion. Within a generation, too, the net trade has advanced by leaps and bounds. The old heavy cord nets have given way before the light tough nets of cotton, occupying far less room, being much handier to work, and even more enduring. This is one of the marked improvements that have enabled boats to carry up to two miles of netting. Then, netting by machinery has cheapened the article, and thrown free the labour of the fisherman's family, formerly devoted to keeping up the supply. The making of cordage, the manufacture of hooks, the trade in salt and staves for casks, are all great industries following in the wake of the fishing trade. So important to Scotland is the herring barrel, that the utmost stringency is enforced as to its make, its dimensions, and the mode in which it is put together; and the fishery officers of the Fishery Board for Scotland are by statute required to be skilled coopers. We owe to the Highland and Agricultural Society of Scotland, the most powerful and influential Incorporated Society in Scotland, an early effort to develop the Highland fisheries. Such towns as Tobermory, Portree, and Ullapool are the result of this effort. Castle Bay in Barra, lately a hopeless conglomeration of depressing erections, is leaping into form and comfort from a foundation of herring and cod. Many have seen the inhabitants of a clachan gradually emerge from hopeless barbarism on the backs of cod-fish. In came the grocer and the "merchant," in came the hotel-keeper to meet the well-to-do buyers, the older men might take to rope-spinning, and the women and girls found lucrative employment. At first all was rude enough, but with increasing means of comfort, and a few examples, the advance was steady.

Then the steamers hurry in for cargoes, and all the other concomitants of civilisation throng thither to partake of the wealth so readily gathered. Whatever of mineral or other wealth Newfoundland may have developed, we owe to the attention she demanded for her fisheries; and whatever of wealth of any kind the remoter parts of Scotland may one day develop, she will similarly owe to her rich seas. The towns of the west of France originally owe their wealth to the fishing industry that acted as pioneer to numberless others. Their oil would have little outlet but for the sardine fishery; their salt pans would be meagre but for their fishing boats; while the trade that developed from Bordeaux to Nantes was pioneered by their hardy whalers. The Hanse towns of Germany were mainly started upon the rich herring fisheries of the Baltic, but these have long disappeared. Those of Norway and Sweden equally took flight after a time, and gave place to the Scotch, pioneered by the Dutchmen. It is true we have traditions of a great Highland herring emporium in the neighbourhood of Fort-William, to which in early ages vessels gathered from the Continent; but, so far as history goes, we owe the development of our fisheries to emulation of the Dutch. It is more than probable that Flemish merchants were the originators of our fisheries, as they certainly were of our manufactures.

I have sought to indicate the great world movements created by the fisheries in their mature development, for while hunting has remained a degraded employment or an amusement, the originally degraded fishing has become steadily elevated into a great and a stable industry. Fleets have been built for it, and manufactures originated for it, while great wars have been undertaken by civilised nations to secure freedom in its pursuit. New lands have been exploited that the wealth of the waters might be garnered more rapidly and free from competition. Fishing, which throughout the early world has been the lot of the poor and miserable, is being created a great art. Steam has become its handmaiden, and chemistry its servant; government is its anxious guardian, and the multitude, both masses and classes, in one direction or another its enthusiastic devotee. It is now having its revenge, and, what is more to the purpose, the fisherman is reaping to some extent his reward.

Since the salting of herrings in barrels, the great impetus to the fishing trade has been communication. The herring trade, all over, to-day is probably no greater than it was in the days of Dutch ascendancy, but other fisheries have advanced at a tremendous ratio. In the earliest work on country life, and how to manage the country mansion systematically, that we know of in English—called "The Booke of The Countrie Farme," translated with additions from the French by Richard Surflet, Practitioner in Physicke—we have an interesting account of the "Poole Fish-pond, and Ditch for fish" that was to supply the household with all manner of fresh-water fishes. There are those in England who think we are coming back to that state of things, and Mr. Burgess is making great efforts to stimulate the public to grow their own fish at their own doors. But so long as we can obtain such delicious fish as the haddock or cod for a moderate price, even in our inland villages, it is not to be anticipated that this early effort at fish culture will be greatly revived in this country, nowhere far away from the sea coast as we are. Our greatest danger, however, lies in the supposition that fish culture or fish care is only applicable to inland waters. Professor Huxley has led the way in the view that our sea-fisheries were inexhaustible, that no laws we could make would benefit them in our present condition of blissful ignorance, and that any species of fishing was fair at sea. There is, no doubt, a modicum of truth in his views, but they were mostly based on a misconception. They have resulted in the almost extermination of the lobster, and in the destruction of our inshore fishing. The great depression of trade, from which we are just preparing to lift our heads, has come on the top of railway communication to stimulate too suddenly the exploitation of the nearer fisheries. The owners of tug-boats lying idle in the Tyne and other centres of maritime commerce invested in a trawl net, and started to compete with the skilled fishermen of the North Sea. It mattered little to them what injury was done to fishing, it was only to be a temporary occupation to be made the most of—"after them the deluge!" The result was that a multitude of steam trawlers were let loose upon the coast, "to do no possible harm" according to some authorities, but certainly to introduce a powerful armament and far-reaching element of disputation into the fishing industry. For of all modes of fish capture none is so aggressive as the steam trawl.

Here, then, is this primitive art become a powerful industry, with shipbuilding and net-making, steam-engine and boiler-making, steam-hauling and other accessories all dependent upon it. The great argument in favour of trawling is the fact that the spawn of most of our marketable fishes float, and consequently cannot be disturbed or injured by the trawl. But except that the fishermen have always made this destruction of spawn a great question, we are not disposed to give weight to it on either side. Inshore trawling, and trawling in such contained waters as the Firth of Clyde, we hold to be injurious, as breaking up the haunts of immature fish, and clearing the ground of the food which these live upon. All the zoophytes and invertebrates generally, and the rough materials which they attach themselves to, are cleared away, and the quiet haunts where nature gives fair play to the youthful denizens of the deep are ruthlessly invaded by a regardless apparatus.

We look to these great steam trawlers exploiting the outer waters, and becoming the pioneers of fishing and all that follows it in the further west and north. For it is as the great pioneer industry of the northern world that fishing appears to me to be most valuable. But for it a great portion of the most invigorating part of the northern hemisphere would be uninhabited, and almost uninhabitable. Without it the West and North of Scotland could only support a handful of graziers. Our railways look to it for their dividends; our men and women look to it for bread; our vessels depend mainly upon it for cargoes. It is the one great industry of Scotland outside the mineral area, and to it the North of Scotland must mainly look for civilisation and progress in the future, as it has done in the past. It owes to it such harbours or piers as have been constructed; it looks to it to stimulate the early advent of other lines of rail.

I have sought to prove that the fisheries in general have been the pioneers of commerce as well as of colonisation in many parts of the world; to show that they are great factors in our international relations; to prove that they add enormously to the wealth of the nations that energetically pursue them; and that, so far as our own country is concerned, they are the one great industry of the North and West.

IX.—*Primitive Aryan Civilisation.* By JAMES COLVILLE, M.A., D.Sc. (Edin.)

[A Communication from the Philological Section, and read before the Society, 21st November, 1888.]

"THERE is no Aryan race in blood, but whoever, through the imposition of hands, whether of his parents or his foreign masters, has received the Aryan blessing, belongs to that unbroken spiritual succession which began with the first apostles of that noble speech, and continues to the present day in every part of the globe. Aryan, in scientific language, is utterly inapplicable to race. It means language and nothing but language; and if we speak of Aryan race at all, we should know that it means no more than $x+$ Aryan speech." Thus does Prof. Max Müller tell us, with no lack of emphasis, that in attempting to reconstruct an ideal social unity for the Aryan race we must not look for aid to ethnology. The question is one which concerns the continuity of speech not of blood, an inheritance of mental attitude towards the world of spiritual and natural phenomena within and without us far subtler and profounder than any perpetuation of the characteristics of complexion and feature; for an Aryan speech writes its own history in virtue of those inherent principles which govern its growth and decay, or rather regeneration—principles which, by reason of their persistency of type and uniformity of action, alone go far to prove in this case a primitive social unity. What those principles are it is not the object of this paper either to investigate or prove, but rather to show how those mutual affinities, which are known to exist within a European unity of tongues, and connect themselves again with a certain well-marked Asiatic unity, point to a time when the makers of those tongues dwelt somewhere together, and developed a common civilisation whose leading characteristics are stamped upon Ayran progress down to the present day.

If we exclude, on the one hand, the Magyars of the Hungarian plain and the Osmanli of Turkey—both the remains of an irruption from Asia within the historic period,—and, on the other, the prehistoric Basques of the Pyrenees and the nomadic Lapps and Finns of the northern mark, we find that all the languages of modern Europe have well-established racial affinities. They group themselves round four centres, which, again, are further reducible to two. Let us regard the map of Europe as a rhomboidal figure with its greater axis lying east and west, and corresponding to the line of the Alps with their prolongations. In the lower half, along the sunlit slopes that look to the sparkling Mediterranean, bejewelled with islets, place the classical tongues—Greek right, Latin and her Romance sisters central and left. In the upper half, again, across the snowy peaks and stretching far northwards over the great central plain, lost amid elfin meres and gnome-haunted forest, roam the Teutons. By the eastern angle, pressing close for hundreds of years upon Roman and Teuton alike, come the Slavs of the Southern Steppes and the Sarmatian plain; while, thrust far away into the western angle, the old-world Celt looks sadly on the mist-clad mountain and the melancholy western main. These four groups, with a wide range of dialectic variation peculiar to each, have yet innumerable features in common that constitute them a distinct European unity. They range themselves, however, under two distinct types—a Classical and a Teutonic. The Slav is a link of connection to east, Celt to west, but both lean to south, and, as far as phonetic affinities are concerned, are Aryan dialects of the Classical type. The phonetic contrasts that differentiate a Teutonic from a Classical tongue were long ago formulated by Grimm in his well-known law. It simplifies this law, and does not impair its practical usefulness, to treat it as Prof. Skeat does. He regards the interchange between Low and High German, which is, strictly speaking, Grimm's *Laut-verschiebung*, as merely a dialectic variation within the Teutonic group, and thus we get but two interchanges instead of three. Bear in mind, too, that the law applies to the nine mute checks ranged under H-ards (*k*, *t*, *p*), A-spirates (*k·h*, *t·h*, *p·h*), and S-ofts (*g*, *d*, *b*). A cognate term then—not a loan-word—belonging to the classical group (Greek, Latin, Celtic, Slav), if found in the Teutonic group (Gothic, English, Dutch, German, Norse), will have its mutes changed according to the mnemonic formula H. A. S into A. S. H., where those letters stand for the initials of the mute-sets Hards, Aspirates, Softs. The following table illustrates Grimm's law, thus modified:—

H.			A.			S.		
k.	*t.*	*p.*	*k·h*	*t·h*	*p·h*	*g.*	*d.*	*b.*
C-ord (is)	T-res	P-ed-(is)	Χ-όλη	Θ-υγάτηρ	F-ero	G-enus	D-uo	—
H-eart	Th-ree	F-oot	G-all	D-ochter	B-ear	K-in	T-wo	—
h.	*t·h*	*f.*	*g.*	*d.*	*b.*	*k.*	*t.*	*p.*
A.			S.			H.		

A few points call for special remark. Latin distinguishes the aspirates very imperfectly, an idiosyncrasy that is shared by the Romance dialects, notably Spanish. The lip checks (*b. p.*) would seem to have been so imperfectly developed in primitive types that no good examples of the interchange of these letters can be found. Further, the law by no means exhausts the evidence for affinity. Vowel changes, and especially a comparison of grammatical inflexions, supply irrefragable proof of the primitive unity out of which these dialects developed themselves.

The discovery of Sanskrit to western scholars, dating from the foundation of the Calcutta Asiatic Society (1784), revealed a singularly suggestive Aryan unity existing in the far east, and possessing in its sacred books a literature that was old long before the Homeric poems took definite shape. The ancestors of the Hindoos and the Old Persians reached the Indus together, and there developed a common religious and social system. They named the great river, Sindhu, the goer, the runner. The country beyond was named, from the river, Sindhya, the Scinde of Napier's punning despatch, *Peccavi* (I have sinned). After this people divided, the western or Persian branch developed phonetic laws of their own, such as the use of an *h* for a Sanskrit *s*, so that, when the Greeks came in contact with them, these transmitted to us the name of the river as the Hindus or Indus, and the country as Hindia or India. This Persian or Iranic branch spread over the plateau of Iran, and their speech is now known as that of the Zend-Avesta and the cuneiform inscriptions of Darius. Their Hindoo kinsmen pushed beyond the country of the seven rivers into the Dakshinaranya, or great southern forest of the Deccan, calling the aborigines blacks, just as in later ages Clive's soldiers knocked their high-caste descendants on the head as niggers. A great religious schism seems to have accentuated some original distinctions between the two peoples. The Sanskrit *deva*, a god, became in Zend a demon, while the Hindoos retaliated by making *Asura* a giant at war with the Vedic gods. The Persians, on the other hand, put *Asura* (R. *as*—, to be, cp. Jehovah) in the place of honour, who then became the Ahura-mazda or Ormuzd of Zoroastrian dualism. But the Sanskrit grammarians had no difficulty in inventing a derivation for the word, namely, *a* not, and *sura* a god.

The proofs of the connection between this Asiatic and the former European unity form the very kernel of Comparative Philology. They are invaluable, not alone in the phonetic aspect of the question (Sanskrit and Zend range themselves, as far as Grimm's law is concerned, under the Classical or southern European group), but still more, and of far deeper import, in respect of the clue they afford to the difficult problems of Comparative Grammar and Mythology. Suffice it here to say that Sanskrit explains the significance of the name Aryan as an Eponym for the whole family. In the Vedas the Aryas are believers in the Vedic gods in opposition to their Gentile enemies, the Dasyus. Later, it meant belonging to the three upper castes, and especially the third or cultivators of the soil. Its root is seen in Lat. *ar-are* and English *ear*, to plough. The name points to that immemorial custom which loves to dignify a nation or a family by associating its origin with the possession of land, and proves the early existence of that Aryan earth hunger which reaches its acme in Ireland, the Erin that is said to be just another form of the common race-name.

No one can ever venture to conjecture when all these races existed as a primitive unity, or why they broke up, or in what order, or whence sprung the initiative for that dialectic growth to which they owed their phonetic differences. But we have learned to know and distinguish the various branches of the stock, and to formulate the law under which all comparisons of them, one with another, must be studied. It remains now to apply this knowledge by comparing a few groups of cognate terms in the Aryan dialects in evidence of a linguistic unity, subsisting among the various members of the family, and of a relatively advanced stage of civilisation reached by the proto-Aryans before their separation. Professor Max Müller has drawn up similar lists in his "Biographies of Words," and there he lays it down as a general rule "that whatever words are shared in common by Sanskrit and Zend on one side and any one of the Aryan languages on the other, existed before the great Aryan separation took place, and may be used as throwing light on Aryan civilisation, such as it was at that distant time." To this it has to be added that cognate terms, peculiar to one only of the unities (Asiatic or European), are evidence that they were developed after the primary schism, but existed antecedent to any secondary schism. Developments by growth within each unity from a common stock of primitive roots are evidence merely of the persistency of those distinctive Aryan peculiarities, the inflexional system and that significant word-change whereby we continually specialise the general or generalise the special. Thus we confer epithets that in course of time become divested of their meaning—"the counters of wise men but the money of fools,"—and consequently require an effort of literary emphasis to vitalise or supplant them, the secret, in short, of a rich and expressive vocabulary and a copious literature.

CONTRACTIONS:—Vedic, Sanskrit, Zend (Old Persian), Greek, Latin, Celtic (Irish, Welsh, Cornish, Gaelic), Slavonic, Lituanian, Russian, Teutonic, Old High German, German, Icelandic, Gothic, Anglo-Saxon, Scottish, Old and Middle English, shown by their initials. Where no meaning is given after a word it may be assumed to be identical with that of the head-word under which it stands. Roots and radical meanings are in italic type.

AUTHORITIES CONSULTED:—Prof. Aufrecht's Lectures; Max Müller, Biographies of Words, 1888; Skeat, English Etymological Dict., 1884; Fick, Vergl. Wörterbuch der Indo-ger. Sprachen, 1870; Curtius, Grundzüge der Griech. Etymol., 1873.

I.—FAMILY TIES.

CHILD-WORDS.—*Papa*, S. and Gr. tâta, L. tăta, C. tat, Sl. teta, Go. atta. *Ma-ma*, S. attâ, T. aithei. *Foster-parent*, Ved. nanâ, L. nonnus, nonna (nun), Ved. ambhâ, Icel. Embla = Ambhâlâ (ancestress of human race), Ger. Amme.

FATHER, *Pa—*, *protector*, S. pitár, Gr. and L. pater, T. fadar, M.E. fader. MOTHER, *Ma—*, *manager*, S. mâtár, L. and Sl. mater, C. máther, T. modar, M.E. moder. HUSBAND, *ruler*, S. pati, L. potis (able), Sl. pats, Go.-fath. WIFE = *producer*, Ved. Gnâ (wife of the gods), S. *g*âni (gana, wife) γυνή, Sl. jena, C. ben, Go. kwen, queen, quean. SON = *begotten, or male child*, Sl. and Go. sûnu, υἱός (συιος), C. suth. DAUGHTER = *milkmaid*, S. duhitar, θυγάτηρ, Sl. dukter, Ir. dear, Go. dauhtar. BROTHER, *bearer*, S. bhrâtar, L. frater, Gael. brathair, Sl. bratru, Go. bróthar.

[illegible]

[illegible] [illegible], [illegible] [illegible],
[illegible] [illegible],
[illegible] [illegible] O.K.
[illegible] S.
[illegible] Ger.
[illegible] a little
[illegible] there
[illegible]

[illegible]

and Lat. nepot (is), from a root *nap* = bind. With this our nephew and niece are cognate.

II.—MAN GENERALLY.

Man = (a) *thinker*, Ved. Mánu, L. mâs (mans), T. Mannus, Go. mans; = (b) *chosen*, *hero*, S. vîra, L. vir, Ir. fear, Lit. vyras, Icel. verr, Go. wair, E. wor-ld, Ger. Wel-t; = (c) *strong*, S. nara, náry-a (manly), Oscan ner, Nero, Neria (wife of Mars) ἀνήρ; = (d) *terrestrian*, L. homo, Lit. zeme (land), Go. guman, yeoman, bride-groom. Young = *guarded*, S. yuvan, L. juvenis, Lit. jaunas, Go. juggo. Child = *conceived*, S. vi-garbha, Go. kil-thei, child, calf.

Of these terms the first (a) is specially Teutonic. The Hindoos and the Teutons both used the word, man, for the prototype or ancestor of the human race, and both recognised in man the possession of the god-like gift of reason that looks before and after. The commonest later names in Sans. are mân-ava and man-ushya. Go. mannisk is Ger. Men-sch, and is adjectival. The second (b) is the most widely diffused—S. vâra = suitor, vírya = vires, vir-tus. Its compounds are extremely interesting; decurio and centurio contain it. Cantuarii is Latinised for Kent-were (men of Kent), wergeld was compensation for manslaughter, wor-ld is O.E. wer-old, the age of man, a seculum and sum of human experience, affording curious comparison with other modes of expressing such a wide generalisation. The third (c) is entirely awanting in Teut. and Slav. In Osc. ner was applied to the nobles in the state. The fourth (d) is not in Sans., and has had little vitality in Teut. The Go. guman Ulfilas applies to Zacchæus.

III.—HOME.

House = *builded*, S. damà, L. domus, Sl. domu, C. dam, Go. timrjan (build), timber, Ger. Zimmer. Door.—S. dvar (dhvar), θύρα, L. fores, Lit. durys (pl.) Go. daur. Straw-bed.—S. stara, L. torus, C. srath, Sl. straje, Go. strau-ja. Hamlet (1) = *abode* (viç = enter) S. veça, vaika, οἶκος, L. vîcus (veicus), Sl. visi, Go. weihs. (2) *Fenced place.*—(a) S. vara-ta, Worth (village). (b) O.E. tûn = town, Ger. Zaun (hedge). (c) S. pur (*strong place*), pura, πόλις, Lit. pilis, S. puru = plenus, plebs.

As the names for man show that the primitive Aryans had advanced far beyond the simple concepts that clustered round the hearth and child-life, and could cope with epithets that implied considerable powers of reflection and generalisation, so do those for house and home show a stage of comfort very different from that of the neolithic cave-dweller or the nomad Eskimo. One fancies in the terms for hamlet a distinction between northern and southern Aryans, due probably to the condition of the country over which each set had spread. In both cases a simple enclosure constituted a hamlet—outside, the village mark or common pasture land, and within, the homes. To this day in many parts of Germany the scattered homestead is unknown, the farmyard being a Hof in a village. The Sans. and Greek terms, however, add to the notion of a defended place that of a busy crowded populace that made its acropolis the rallying point for a more lively civic development in street and agora. Significant in this connection is the commonest later Sans. for a man, *puru-sha*, literally a townsman. The favourite Teutonic town, on the other hand, points to a more scattered backwoodsman kind of settlement. The North German plain is one vast monotonous expanse of wood and water, within whose limits the lonely settlers would develop a simpler bucolic society, slow of wit, dreamy, but home-loving. In Lowland Scotland a farm homestead is a town. Even a few houses standing apart and supposed to be, if not actually, enclosed within a hedge fence, form the cotton or cot-toun of the farm.

IV.—DOMESTIC ANIMALS.

CATTLE—[illegible]—S. [illegible] L. pecus, Sl. [illegible] A.-S. [illegible] Ger. Vieh [illegible]. [illegible] = *strong.*—Ved. [illegible] (strong), Gr. and L. taurus, [illegible] W. tarw, [illegible] steer. Ox = *carrier.*—S. [illegible] L. [illegible] W. [illegible] Goth. auhsa, cp. wax [illegible]—S. [illegible] gaus (m. and f.), [illegible] L. bos [illegible] Ger. Kuh (kavi); (b) [illegible] L. [illegible] Lit. [illegible] (infans), [illegible] S. avi, [illegible] L. ovis [illegible] awi-str (fold), [illegible]—S. [illegible] wolly), [illegible] L. vellus (fleece), [illegible] = *agile.*—S. aga [illegible] S. [illegible] = *quick.*—S. açva [illegible] L. equus [illegible] Epona (goddess of horses), Lit. aszva, W. osw, Go. aihus, A.-S. ëhu. Foal = *begotten.* —S. pu-tra (son), pota (young), L. pullus, Go. fula, E. filly. Pig = (a) *produced*, S. sû-kara, ὗς, L. sus, Lit. svini-ja, T. sv-ein; (b) = *grubber*, S. grishvi (boar), ghrish-ti (piggie) χοῖρος (χορσιος), Norse and Sc. gris, E. gris-kin. Dog.—Ved. and S. çvan, κύων, L. canis (cvanis), Sl. szun, Ir. cu, Go. hund.

These terms illustrate still more clearly the simple agricultural life of the Aryans. They surround themselves with those domestic animals that still tenant every homestead, and name them with intelligent observation. All the dialects agree in giving a general significance to the name for cattle, and from the earliest period there is attached to it the sense of property, cp. cattle (capitalia), capital, and chattels. The beast of burden is the sturdy ox. In Sans. go-pa, a cowherd, gives a common word to rule or govern, and the Hindoo title Gaikwar still preserves the importance of the original office. The Umbrian *filia sus* is a sucking pig. That so expressive and wide-spread a name as was given to the Aryan horse has not been preserved in common use among the Teutons is intelligible, and points to the east and the open plain as its home. The Romance dialects have dropped the common Latin equus. That the initial aspirate in Greek is wrong is shown by such names as Aristippus.

V.—WILD ANIMALS.

Beast=O.E. *deer*, θήρ (φηρ) L. fera, Sl. zveri, Go. dius. Bear=*shining*, S. riksha (arksa), ἄρκτος, L. ursus (urcsus), Lit. lokis, Ir. art. Wolf = *tearer, robber*, S. vrika (Ved. = enemy). λύκος, L. lupus, Sl. vluku, C. fael Go. wulfs. Mouse = *thief*, S. mûsh, μῦς, L. mus, Sl. misi, A.-S. mûs, pl.—i, mys (mice = mise), L. mus—culus (muscle, creeping thing). Hare = *cleft* (nose), S. çaça (çasa), S. 'man in moon' is hare in moon, Sl. sasins, T. haso, hare. Serpent = (a) *throttler, constrictor*, S. ahi (aghi), ἔχις, (viper), L. anguis, Lit. angis, ἔγχελυς = anguilla (eel), C. esc-uing (water-snake), M.E. el (agla), Ger. Aal.; (b) *creeper*, S. sarpa ἑρπετόν, serpens.

VI.—BIRDS.

Bird, generally, S. vi, οἰ-ωνός, L. avis, ovum, Sl. aje, C.og, T.ei (egg) pl. eigir.

Goose = *gaping, laughing*, S. hamsa (ghansa), χήν, L. anser, C. geiss (swan), Russ. gus', Bohemian hus (cp. John Huss), O.H.G.

kans, A.-S. gós (gans). DUCK, S. âti, L. anat—, νῆττα (ανετια), Lit. antis, O.H.G. anut, O.E. ened, M.E. ened, d-rake (end-rik = duck-king). CROW = (a) *noisy*, S. kârava, κόραξ, L. corvus, O.H.G. hraban, raven, L. crep-are, *make a noise;* (b) *croaker*, S. kruç (croak), Sl. kruk, C. cru, O.H.G. hruoh, rook. CRANE = *calling*, Z. krounkn, γέρανος, L. grus, C. garan, Sl. zervi, A-S. cran. CUCKOO, S. kokilá, κόκκυξ, L. cuculus, Sl. kukavica, C. cuach, T. kuckuk, Sc. gowk (gauche, gawky). OWL, S. uluka, ὀλολυγαία, L. ulûcus, Sc. hoolet.

VII.—PLANT LIFE.

BIRCH, S. bhûr*ga*, Russ. bereza, Sc. birk, M.E. birche. BEECH or OAK, [S. bhaga], S. bhaksh to eat, φηγός, L. fagus, O.H.G. puohha (buche), A-S. bók, O.E. bécen (adj.). SALLOW = *water-haunting*, S. sara a pond, ἑλίκη, L. salix, Ir. saileach. O.H.G. salahá, M.E. salwe, Sc. sauch. OSIER, R. *wi*—, *plait*, S. veta-sá (reed), ἰτέα (willow), L. vitis (vine), W. gwden, Lit. zil-wittis (gray willow for baskets), Danish vidie, E. withe, wind, wood? REED, S. kaláma (reed-pen), κάλαμος, L. culmus (stalk), C. kalaf, Dutch halm, E. haulm (der. quill).

These three groups are all important as affording some clue to the common home. The larger *feræ naturæ* are absent. Those we have here are familiar to the northern verge of the Temperate Zone. The ordinary features of the bear are overlooked here, and a name is given him that is connected with the place he occupies in mythology. Similarly, the name of the hare is accounted for by early folk-lore, in which he plays a large part all over the Aryan world. Under serpent-words it should be noted that there is no trace of any worship of the creature. In the larger forms it is dreaded, but for the harmless ones there is no change of radical meaning. From the Celtic clearly comes the Scotch ask or esk, the eft or newt. The bird-terms are few and all northern, notably the crane, which does not extend further east than Armenia. The use of the word as a machine, as well as bird, seems very old. These bird-terms are all of the imitative kind. Such creatures all attract attention first by their cries.

VIII.—THE FARM.

FIELD. R. *ag*—, *drive*, V. agra (agra, place where cattle are driven out), ἀγρός, L. ager, Go. akr, E. acre. PATH, R. *pat-*, *spat-*, *stretch out*, S. pathas, πάτος, L. pons (pathway), Sl. pati, T. fad, Sc.

paeth. PLOUGH, S. árya landholder, L. ar-are, Sl. orati to plough, Ir. ar-aim I plough, S. irâ and urvarâ = ἔραζε, ἄρουρα = arvum (ploughed land); S. ar-itra = C. ar-athor = L. ar-atrum (a plough) Norse aror, ἐρετμός = L. remus (oar); Go. ar-jan = M.E. erien = ear (to plough), oar. SOWING, R. *sa—, cast, scatter.* S. si-tâ (furrow), L. sero (seso), Go. saian. WAIN, R. *wah—, carry,* S. vâhana, ὄχος, L. vehiculum, Sl. vozw, C. fen, A-S. waegn and waen. AXLE. R. *ag—, drive.* S. áksha, ἄξων, L. axis, C. echel, A.-S. eax, O.H.G. ahs-ala (shoulder), Sc. oxter (arm-pit). YOKE, R. *yug-, join,* S. yugá, ζυγόν, L. jugum, Lit. junga, W. iaw, A.-S. geoc, ioc.

Farm-words show a simple, rustic, but by no means nomadic, life. The agra reminds us of the old Scotch loanin or field kept in grass near the farm-town. The roads are simply footpaths leading to the out-fields or the village mark. The North-Western dialects agree in restricting the root ar- to plowing, but the common name for plough seems to have been lost, for the modern word has been developed within the Teutonic unity — Frisian and Sc. pleuch, Swedish plog, Russ. pluge. It is the same as plug, a block of wood. The familiar Teut. hoe, Sc. howk, is in Sans. koka, a name for the wolf.

IX.—FOOD.

CORN = R. *ju-, sustainer,* S. yáva (barley), yávasa (fodder), ζειαί, Lit. yavas, C. eórna. MEAL = (*a*) R. *mar—ground, rubbed,* S. malana (rubbing), μύλη, S. mola, Sl. melja, C. melim, Go. malan (to grind); (*b*) R. *kar—crumbled,* S. *k*urna (flour), γῦρις, L. granum, Sl. zruno, C. gran, Go. kwairnus a quern, E. cor-n, ker-nel, churn (Sc. kirn). MEAD, S. madhu (sweet, honey), μέθυ, L. mel, Sl. medus, A.-S. medu, O.Ir. med (drunk). WATER, R. *wad—wet,* S. udan, ὕδωρ, L. udus, K. dour, Russ. vod-kja = Ir. uis-ce (whisky), Go. wato. SALT, R. *sar—flow, that which runs together,* cp. serum, S. saras (lake), ἅλς, L. sal, Ir. salann, R. sole, Go. sal-t., Sc. Saline (place-name).

X.—OCCUPATIONS.

BUILD, S. dru (a tree), dâru (wood), δόρυ, (spear-shaft), Ir. daur, Sl. drevo, Go. triw-eins (adj. = treen), axle-tree. CUT, S. kartanî (scissors), κείρω, L. cul-ter, Go. hairu (sword). PLAT, S. *prik,* πλέκω, and L. plico, Go. flahta (plaited), Sc. flaik (hurdle), E. flax. WEAVE, S. va, ûrna-vâbhi (wool-spinner, spider), ὑφή (web), L.

[illegible]

—*begotten.*—S. ganas, γένος, L. genus, Go. kuni (race, tribe), E. kind-red.

Season-words yield a further hint of a northern Continental home, with a more or less humid climate in which the welcome change from the long ungenial winter was as the burst of sunshine through the cold and mist of a gloomy night, and the dawn of gladsome spring was merged in a too short summer-day. Time was measured by the moon, of little service otherwise in that wolf-haunted forest land, and therefore playing but a small part in primitive mythology. Day is the reign of divine, life-giving light, as night is the waning of Nature's powers in a death-like gloom. The terms for civil life show that a more than rudimentary conception of social polity existed. The basis of union is kinship by blood, and the ruler is the father of related families, the guardian that defended the tribe on its threshold, the encircling mark, or even the one most distinguished by personal merit chosen to a still wider sway.

XIII.—MIND.

THINKING.—R. *ma-*, *measure*, S. manas, μένος, L. mens, Sl. mineti, C. menme, Go. mun-s. WIT=*seeing clearly*, S. vid, οἶδα, L. videre, Sl. vedeti, Go. wit-an, Ger. wiss-en (to know). KNOW-ING, R. *make to know*, *teach*, S. gânâmi (I know), γνῶσις, L. g-nosco, Sl. znati, Go. kannjan (make known), Sc. ken. WILLING = *choose*, S. vri (choose), vára (wish, excellent), L. volo, S. voliti, Go. wil-jan,—will, well. AWE, R. *agh-*, *choke*, S. amha (angha, constraint, pain), ἄχος, Ir. eaghal, Go. agis,—awe, ugly, ug-some.

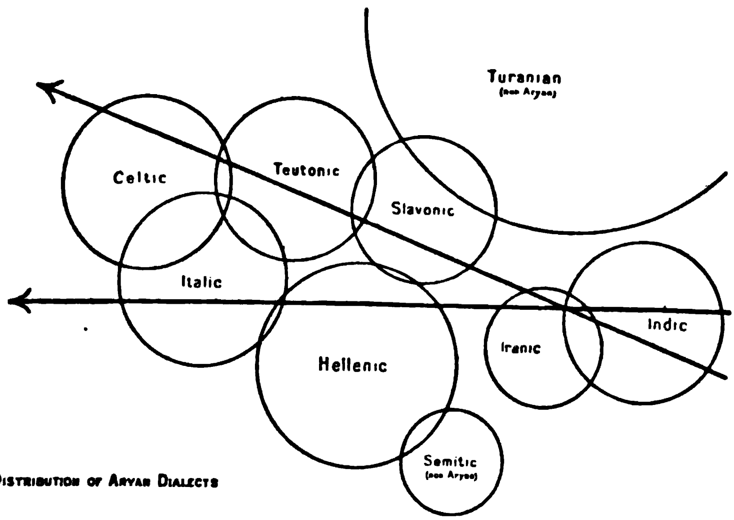
XIV.—MYTH.

SUN = *light-giver*, S. sûra, svar (sky), σείριος, = Sirius, L. ser-enus = σελήνη (svarânâ), C. sail, Lit. saul, Go. sauil. STARO = *strewn or light-strewers*,—Ved. star-as, ἀστήρ, L. stella (ster-ula), C. steren, Go. stairno. WIND AND WEATHER,—R. *vâ—*, *blow*, vâta, L. ventus, Lit. vetra, Go. waian, A.-S. weder,—weather: R. *an—*, *breathe*, S. anila, ἄνεμος, animus, Go. and (breath). THUNDER (a) = *sound*, *groan*, S. stanita, L. tonitru, A-S. thunnr, ICEL. Thor (god of thunder), Thurs-day; (b) = *strike*, S. Vadhá-tra (thunder-bolt), T. Wuodan (Woden), Odin, Wednes-day. DARKNESS = *what dims*, *mist*, S. Ragas, ragani (night), Gr. Erebus, Orpheus, Go. rikwis, Sc. reek (smoke). FIRE (a) S. agni, L. ignis, Sl. ogni; (b) *firestick*, S. pramantha, Prometheus. BUG-BEAR, S. Bhaga, Phrygian Zeus Bagaios, Ir. puca (sprite Puck), Sc. bogle (scare-crow). HEAVEN = (a) *bright sky*, S. dyaus, Dyaus-pitar = Dies-piter = Jupiter, Diana, Janus, S. deva (a god), Lit. devas, C. di, Norse Edda, Tivar (gods), Tyr (god of war), Tuesday = Tiwes-daeg; (b) = *all-embracing and all-seeing*, S. Varuna (sky) Uranus; (c) = *living, being.*—R *as, to be*, V. Asura, Z. Ahura-mazda, cp. Jehovah = *I am that I am.*

The terms under these heads enable us to plant Aryan civilisation deeper, showing as they do a more profound grasp of what is in the best sense culture. They prove the truth of the maxim—"Nil in intellectu nisi prius in sensu." Whatever may be the psychologist's verdict on the scholastic question of *primum cognitum* and *primum appellatum*, these primitive concepts tell us that the Aryans reached the abstract through the concrete, and moved in a world of quick sensations. They had even grasped the Kantian distinction of subjective and objective, differentiating the *wissen* from the *kennen*, the *savoir* from the *connaitre.* The higher consciousness is choice, and the most solemn and impressive symbol for physical pain and religious dread is found in the sensation of choking. Yet here we reach the anti-climax, for in the mouths of us moderns the awful is anything or nothing at all. The last head reveals to us the boundless region of comparative mythology. Here we read the unconscious literature of the Aryans, the sacred books of the race. It has the same physical basis as the terms for mental operations. The cardinal fact of the Aryan's simple existence was the ever-ending, ever-beginning struggle of the bright sun, eternal type of his own lot. Against his hero are arranged the powers of nature, the demons of the cloud and the darkness. His love is the dawn-nymph. In the first blush of their love she coyly eludes him; fair but faithless and fleeting,—in the heat of the day she will haunt him, till once again in the glory of his manhood she meets his embraces, and they sink together into the mystic Avillon with his twilight smile irradiating her azure brow. Thus did the simple Aryan endow the phases of natural life with a personality like his own; on this all-absorbing theme he lavished his nascent powers of literary expression in the significant epithet; and all this with such truth and vitality that, from Homer down to the latest modern novel, the primitive solar myth—the varying fortunes of hero and heroine, the cruel machinations that separate them, and their final re-union—dominates the whole realm of literary make-believe.

Prof. Max Müller sums up the results of the foregoing inquiry in these words :—"Looking then at the whole evidence which the languages of the various Aryan nations still supply, we perceive that before their separation their life was that of agricultural nomads, and probably most like the life of the ancient Germans, as described by Tacitus. They knew the arts of ploughing, of making roads, of building ships and carts, of weaving and sewing, and of erecting strongholds and houses, more or less substantial. They could count, and they had divided the year into months. They had tamed the most important domestic animals; they were acquainted with the most useful metals, and were armed with hatchets and swords, whether for peaceful or for warlike purposes. They followed their leaders and kings, obeyed their laws and customs; and were impressed with the idea of a Divine Being, which they invoked by various names."

It is impossible to say when or in what way the causes which have produced the existing distribution of the Aryan dialects began to take effect. The accompanying diagram is an attempt to show to the eye their mutual relations, not alone in connection with a common centre, but also as developments round independent nuclei. It is due to



DISTRIBUTION OF ARYAN DIALECTS

a highly-elaborated flexional system, and a very early appearance of literary forms, among many other considerations, that we should place the common centre of emanation nearer to the Asiatic than to the European unity. There is no doubt, moreover, that these dialects range themselves in groups that travel on divergent lines. We are on historical ground, too, in saying that the original rupture between north-west and south-east was rendered permanent by internal causes due to the growth of an elaborate social and sacerdotal system peculiar to the Asiatic section, and by such external agencies as the inroads of the Tatar hordes from Central Asia, and the spread of Semitic influences from the south-west. Bearing in mind that the oldest names for the outstanding features of the country in Europe are of Celtic origin, and that the Celts are, both in point of locality and civil progress, an outlying, isolated, and diminishing stock, we may safely infer that they were the first to move westwards. All the traditions of the Græco-Latin stock point to an Eastern origin, and that a very remote one. On the other hand, not till the fourth century do the Teutons emerge from obscurity and take a place in literature. They are then on the lower Danube, but driven into the Empire by ruder barbarians on the north. The translation of the New Testament by the Bishop of the Goths, Ulfilas (about 360 A.D.), constitutes, philologically speaking, the Veda of the Teutons. The language of the Goths retains very many of the characteristics of the primitive Aryans, and throws besides invaluable light on the whole subsequent dialectic growth of the Teutonic tongues. The Slavs, having for centuries to maintain a hard contest between their Teutonic brethren on the west of the Sarmatian plain and the Mongol savages of the east, have arisen but slowly out of their primitive barbarism. Their language, however, preserves some singularly interesting archaisms.

As the great schism that has permanently separated the Asiatic from the European groups brings us nearest to the proto-Aryan period, whatever throws light upon the significance of that event serves still further to illustrate the stage of culture which the combined stock had reached. We have seen on what points of material, mental, and moral culture they all agree. It will be important to notice in what respects they differ. Roots will be found to divide in a mysterious way, so that the north-western group, for example, prefers to express the action of milking as stroking, softening (marg-), the south-eastern as drawing (duh-). Similarly the root ar- goes to Europe as ploughing, and remains in Asia as rowing, the Hindoos betaking themselves to another common radical (karsh—to draw) to express this action; while the Sans. kshuma is supplanted in the west by linen, flax. Of more special growths we have the Vedic soma as a sacred beverage remaining strictly in the east, while vinum spreads all over the west. It was probably due to climatic conditions that the Hindoos added to the primitive set of phonetic symbols such new peculiar forms as characterise the Sans. alphabet. But the most striking proofs of an imperfectly-developed common civilisation remain to be noted. For example, whereas the ear for phonetic variations was so developed as to produce a rich flexional system, and perpetuate minute shades of accentuation, the colour sense, as might be expected, was a late growth. The Sans. for colour is varna, literally what covers, and is the same as vellus and our wool. It was also chosen to express caste, a most significant specialisation of its force. But this vagueness in colour-naming is best shown in the case of the metals. Gold is S. hir-anya, hár-ita, Z. zaranya, zairita, Sl. zlŭtu, zelenu, Go. gulth and our gold, Gr. chrusos. These all agree in naming the metal from its colour, the yellow. From the same stem, however, come S. hari, green and Lat. gilvus, flavus, and our yellow; from S. harit, red, Lat. fulvus. The neutral tint of silver is more easily decided; it is S. ra*g*ata, the white, or ra*g*ata hiranyam, white gold, just as in Scotland zinc was called white iron. The Lat. arg-entum has the radical sense, but it is lost in the Teut. dialects. The third metal shows the greatest variations of colour-naming, so much so that it may have been applied to copper, bronze, or iron. It is in Sans. ayas, Lat. aes, Go. aiz. In Ulfilas the apostles are to take no aiz (money) in their girdles. Gr., Lat., and Teut. have developed their words for iron on quite independent lines. When we deal with the names of commodities that are the products of an advanced civilisation, we are in the region of loan-words, interesting as evidence of a very early commerce, and this necessarily complicates the question as to the higher culture of the proto-Aryans. Some of these loan-words are extremely old—sugar-candy, for example, came from India in the remotest times, crystallised on sticks of cane or bamboo. Sugar is the S. carkara = gravel, Pers. shakar, Lat. saccharum, and Gr. with slight change, M.E. sugre. Candy is S. kandha, a stick, and Pers. quandat, quandi (sugared). The word lives in Lowland Sc. as gundy.

The only point that now remains to be discussed is the home of the Aryas. We were long satisfied with locating it somewhere in Western Asia, probably in the region stretching south from the Caspian and along the valley of the Oxus, on the one side reaching up the slopes of the Paropamisan and Hindoo-Koosh, and on the other to the Armenian Highlands. This position gives us, mindful of the saying, *ex oriente lux*, a reasonable centre of development, and accords well with such historical facts as bear on the point. In respect of natural products and climatic conditions it lends itself to the deductions already drawn from the lists of most widely-diffused terms. But a European centre has long been claimed for the Aryan dispersion, somewhere in South Russia, the Danube, the shores of the Baltic, and so on. This theory would make the proto-Aryans spring from the rude builders of the lake-dwellings and the kitchen-middens. It points to the absence of any common word for lion, tiger, elephant, camel, ape, as inimical to any Asiatic source. It says that the only common trees named, birch and beech, are natives of middle Europe not of Asia. Max Müller discusses the whole question, and replies to this argument on its own lines. There is no doubt that the prehistoric condition of middle Europe was unfavourable to the early growth of civilisation. In point of fact, when there at all, it came late and from the south. Dense forests covered a marshy land. The inhabitants must have been confined to the neighbourhood of lakes or of the sea, where alone were the means of easy subsistence. If, then, the dispersion was from such a centre, there ought to be a common word for fish, yet the Sans. matsya, and the Teut. and Celt. fish are from different radicals; common names for shells and shell-fish are entirely absent. The eel is not found in the Black or Caspian Sea, and the name, though from a common root, is of western and later growth. The sea itself ought to, and does, have a common name, but this proves little. In Sans. maru is a desert, literally that which is dead, and Lat. mare and our mere and extensive Teut., Slav., and Celt. forms point to a western development. Why, on this hypothesis, should the European Aryans forget in the east so prominent a natural environment as this? The name for ship, too, is common. It is Sans. nau, Gr. and Lat. naus, A.-S. naca and Ger. Nachen, a skiff, from a root seen in nare, to swim or float. It primarily applies to a boat on a river or lake, and has not spread far in the Teut. dialects. In bird life the crane is not in Sans. but in Zend, because it does not spread further east than Armenia, while the quail appears both in Sans. and Gr. as the returning one. The crane would be new to those who went west, familiar if they went east. Of plants the general term tree as timber is alone common to all. The naming of individual trees is uncertain. There is no definite common term. Bhurja appears in Sans. as the name of a bark used as writing-material. The beech, used as a food, is confined to the North-west. The word is the name of the oak in Greek. The Lat. quercus, again, is the Teut. fora-ha and our fir. But the whole argument from the plant and animal life forgets that there are a flora and a fauna of altitude as well as of latitude, and it was never implied that the proto-Aryans lived anywhere but on the uplands of western Asia where European trees and familiar animals thrive. So that it is not necessary to admit, as Prof. Max Müller does, that the names for lion, tiger, might have been forgotten by those western tribes that left the haunts of the creature. This would be intelligible, for what ceases to be generally used ceases to be named. Thus in the prelatic days in Scotland the lectern was familiar. As Presbyterianism took hold of the people the reading-desk, known for a while as the letterin, was applied to the precentor's desk, and in time was forgotten as Episcopacy became unpopular. The ape and tiger are strictly tropical. The lion is more widely diffused, and the word is said to be an Indo-Europ. one, signifying the raving or roaring one. The camel presents a real difficulty, for Bactria, the home of a well-known variety, is admittedly near the centre of ancient Aria. Elephant is a loan-word with a curious history that shows its Aryan origin. The animal was unknown in the west till brought to Southern Italy by Pyrrhus, though ivory had been spread by trade. The word elephant appears in the Gothic translation of the New Testament. Ulfilas, at a loss to translate the camel-hair coat of the Baptist, uses ulubandus, his Gothic equivalent for elephant. It was the only name for a large eastern quadruped, known to him, that would suit. The word is apparently Semitic, eleph, an ox, but contains a Sans. stem, ibha, with the Heb. article prefixed. The Sans. ibha, strong, powerful, is a common name applied to the animal, and its appearance in the west points to a familiarity with the creature after the Hindoos reached Southern India and to an early traffic by the Arabian Sea in ivory. The result of this line of argument goes to prove that the hypothesis of an original Aryan home in western Asia, though from the nature of the case unsupportable by direct evidence, accounts better for all the facts than any other.

X.—*On the detection of Mural Pores in the Genus Alveolites.* By JAMES THOMSON, F.G.S., Glasgow, Corresponding Member of the Royal Society of Science of Liège, and Honorary Member of the Royal Ducal Society of Jena.

[Read before the Society, 19th December, 1888.]

IN the March number of the *Geological Magazine*, 1888, Professor H. A. Nicholson contributed an article on the detection of mural pores in thin sections of the *Favositidæ*, and referred to a foot-note of mine in the *Transactions of the Geological Society of Edinburgh*, Vol. V., Part 3., p. 381, in which I stated that the discovery of mural pores in microscopic sections "would be one of the greatest discoveries of modern times;" and also referred to my paper on the genus *Alveolites* of Lamarck (*Proceedings of the Phil. Soc. of Glasgow*, Vol. XIII., Part 1, p. 194, 1881). Prof. Nicholson's remarks are not only misleading, but do not correctly state the facts as given in the latter communication. I therefore feel called upon to reply and to correct the same. The passages in his communication are subjoined:—Page 105. "So far as concerns the genus *Alveolites* (Lam.) in particular, it is unnecessary to criticise the statements contained in the above note, since the note itself contains the plainest proof that Mr. Thomson does not know what the genus *Alveolites* (Lam.) is, and that he is not acquainted with any species of the same. The first point is sufficiently shown by his assertion that 'the type' of the genus *Alveolites* in the collection of Dr. Fleming, as every palæontologist knows, is the familiar *Alveolites suborbicularis* (Lam.) of the Devonian rocks, and is preserved at Paris. The second is equally clear from his speaking of 'the four species of *Alveolites*,' as if there were only four species of the genus, the truth being that 'the four species' to which he refers—namely, *Chætetes septosus* (Flem.), *Ch. depressus* (Flem.) I., *Ch. capillaris* (Phil.), *Ch. Ethe-*

ridgii (Thom.), belong to the genus *Chætetes* (Fisch.), and are not referable to the genus *Alveolites* (Lam.), at all!"*

"As regards the general question involved, in view of all that has been published in recent times, as to the minute structure of the Favositoid corals by Ferd. Romer, Lindström, Schluter, Frech, Foord, R. Etheridge, jun., the present writer, and others, it is difficult to believe that one who professes to have studied Palæozoic corals should speak of the recognition of mural pores in thin sections of *Alveolites* as still unaccomplished,† or of its possible accomplishment as being 'one of the greatest discoveries of modern times.' Even in the days of those great masters, Milne-Edwards and J. Haime, before the method of working by means of thin sections had come into use at all, it was a familiar fact that mural pores could readily be recognised in polished slabs of the Favositoid corals. Mr. Thomson does not appear to have grasped the elementary fact."

In summarising the above, the reader will be led to believe (1) that I do not know the genus *Alveolites* (Lamarck) "or any species of the same;" (2) that I only know of four species of *Alveolites;* (3) that the four species belong to the genus *Chætetes* (Fisch.) and have no relation to the genus *Alveolites* (Lam.); (4) that I have not been able to realise the (said-to-be) fact that mural pores can be detected in thin sections; (5) that mural pores were known to Milne-Edwards and J. Haime; (6) that I have not grasped the elementary facts. As regards the first, second, third, fifth, and sixth points, the best answer that I can offer is to refer to the communication Professor Nicholson mentions—namely, *Proc. Phil. Soc. of Glasgow*, Vol. XIII., p. 194, 1881. A few extracts I subjoin.

* "By 'the genus *Chætetes hyperbolus*,' Mr. Thomson refers, I presume, to the 'species' described by Mr. R. Etheridge, jun., and myself under the name *Chætetes hyperborus*."

[*Note by Author.*—We did expect that the accurate and learned Professor would have been able to recognise that the substitution of an *l* for an *r* was a printer's error.]

† "Mr. Thomson's disbelief in the possibility of recognising mural pores in thin sections of the Favositoid corals is, it may be noted, of comparatively recent growth; thus, in a paper published in the *Proc. Phil. Soc. of Glasgow* in 1881, Mr. Thomson described and figured what he believed to be mural pores in thin sections of *Chætetes Etheridgii* (Thom.), Sp. A reference to his figure (*loc. cit.*, Pl. I., Fig. 7) will show, however, that in this case the supposed mural pores are represented in the centre of the calcite filling up the visceral chamber of the corallite, and that they are really nothing more than granules of calcite."

As regards the fourth—namely, that I did not realise the fact that mural pores could be detected in thin sections, I state, for once and for all, that in no part of that communication do I mention one word regarding thin sections; consequently, Professor Nicholson's rash assertion is misleading. I now venture to assert that possibly I possess as large a series of thin sections of the genus *Alveolites* as is known; they can be measured by many square feet, and in no instance have I detected mural pores in thin longitudinal sections, and, from a careful examination of thousands of examples, I have no hesitation in asserting that to find these perforations in such delicate forms would be one of the greatest discoveries of modern times. Then, as for detecting them in trans verse sections, as indicated by Professor Nicholson—from a much longer experience in the preparation and examination of thin sections than Professor Nicholson can claim,—to accept of such evidence I would regard myself as "rash indeed," well knowing that if a section of coral be ground beyond a certain limit, it is no unusual occurrence to find seeming breaks in the continuity of the structure, which is, therefore, most unreliable evidence to found an opinion upon. I have, however, hundreds of examples of thin transverse sections, in which there are seeming breaks in the walls. These, when carefully examined, however, are found to be the result of fission, which may either be from the extension of the spiniform points from the opposite sides of the corallites, and just preceding their union, and therefore expose a more or less open space at the point of junction; or they may arise from the extension of only one of these spiniform processes, leaving an open space at their union with the wall on the opposite side of the corallite. Of these I have hundreds of examples. From an examination of Professor Nicholson's own plates, I suspect that he has been led to believe that the non-union of the fissiparous processes are transverse sections of mural pores.

As regards the calcite filling the visceral chambers, as he states, and his remark that the mural pores were simply granules of calcite, and that my belief in mural pores is of recent growth—how such an expression could emanate from such an eminent and "accurate observer" is simply surprising. As a reference to my communication on the genus *Alveolites*, 1881 *(loc. cit.)*, indicates clearly that I did know of mural pores, not, however, in thin sections; but in weathered specimens of either of the four species of *Alveolites* from the carboniferous rocks, there is abundant evidence of their presence.

I have also large masses which, when broken, expose in the centre of the mass hundreds of corallites, which, during fossilisation, have been in no way affected by or filled with foreign matter. These not only exhibit the unfilled corallites, but expose the mural pores along the walls in the most perfect condition, which a very careful observer had no difficulty in detecting within the last few hours. Therefore the supposition that I had mistaken granules of calcite for mural pores could only arise through Professor Nicholson's ignorance of the evidence that I do possess, and of which he knows nothing; and I believe that if he had applied the same prudent caution in his examination of the genus *Alveolites* that he indicates in his work on the Tabulate Corals, when describing the genus *Monticulopora* or its allies, p. 276, he would have saved me from referring to such a gross error as the following, namely:—"There is at present no evidence as to the existence of mural pores in *Monticulopora*. Considering the minute size of the tubes and the great difficulty which commonly attends the detection of the apertures (mural pores) in microscopic sections, the non-recognition of pores does not absolutely imply their non-existence."

If my time would permit I am in a position to show that there are mural pores, comparatively large, in the genus *Monticulopora*. Indeed, these are not the only genera that are referred to, and which can be shown to be equally erroneous in their determinations, in his erudite work on the Tabulate Corals.

Regarding my ignorance, I may inform my eminent critic that I not only consulted all the specimens in the museums I had access to in this country, but also the type in Paris; also all the works at my disposal; yea, even Professor Nicholson's elaborate contribution to the "Palæontology of the Province of Ontario," in which he describes no fewer than twelve species of *Alveolites*.

And when in Canada and the United States of America in 1884, I examined all the specimens of the group that my time admitted of, amongst which were some of the species Professor Nicholson had determined and described in the memoir referred to; and I am obliged to state that it would have been more creditable to the author had they been still undetermined, an opinion shared by several well-known palæontologists of that great continent. I will, however, give a few extracts from my paper on the genus *Alveolites (loc. cit.)*, to which Professor Nicholson has referred, believing that what is therein stated will demonstrate that his remarks are not only misleading but are unreliable. For fuller details I beg to refer interested parties to the paper mentioned.

Firstly,—At page 195 I suggest that the different generic and specific names that have been applied to this group may have arisen from the examination of external aspects, and I further state that I have specimens in which the corallites are spherical, semicircular, triangular, pentagonal, hexagonal, and even heptagonal in the same mass,—thus clearly showing that the external aspect was not an infallible guide, either for generic or specific diagnosis.

Secondly,—At page 197 reference is made to the discovery of a specimen in Cunningham Bedland, Dalry, Ayrshire, and subsequently in Charlestown lime quarry, Fifeshire. In each we have mural pores exposed in abundance. The non-discovery of mural pores in specimens from the latter locality induced Prof. Nicholson to delete the genus *Alveolites*, and substitute for *Alv. depressa* (E. and H.) the genus *Chætetes*, and create a new species—namely, *Chæt. hyperborus* (N. & E.). And I have reason to believe that had the learned Professor examined with ordinary care many of the specimens that were procurable, he would have found no difficulty in discovering mural pores.

Thirdly,—At page 198 I briefly refer to the histology of the genus, and point out the reasons adduced by Lamarck, and MM. Edwards and Haime for their definitions of the genus; and at page 199 give a summary of Nicholson and Etheridge's definitions of the genus, and their reasons for substituting the genus *Chætetes* for that of *Alveolites*, that is to say, the absence of mural pores, the erect corallites, and the obliquity of the calices.

Fourth,—At page 200 I state that we have many specimens in which all these conditions are exposed, and, further, that I have submitted these specimens to several of our ablest palæontologists, and that each had found mural pores in all the specimens; and, likewise, that I have a specimen from the Devonian Rocks, Eifel, which so closely resembles some of our carboniferous specimens that it might be mistaken for the latter. Then at page 201 I state that I had failed to find one character in common amongst all the specimens of *Alveolites* and that of *Chætetes*. Again, I refer to the distinctiveness of the generic characters of *Alveolites* and of *Chætetes*, as exemplified in the different modes of reproduction. In order that this should be as clearly defined as possible, I introduced plates, and a summary of the generic descriptions of *Alveolites* and those of *Chætetes;* also a plate showing the distinguishing structural characters of the genus *Favosites*, a genus with which *Alveolites* had been associated by some authors, an error, I believe, arising from the definition of the corallum from the examination of the external aspect. In order that there may be no ambiguity I again introduce the same plates that accompanied that communication (*loc. cit.*), and a *resumé* of the distinguishing characters of each of the three genera.

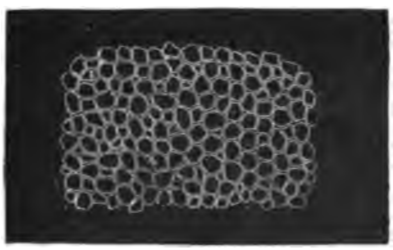
These points may be briefly summarised as follows:—*Favosites* may be readily distinguished (1) by the presence and arrangement of the mural pores, (2) by the mode of development—the carboniferous being intermural, and, in some of the Silurian forms, calicular, and always at the angles of the parent corallites.

Chætetes may at all times be recognised (1) by the flat encrusting sheets and dendriform masses, (2) by the non-existence of mural pores, and (3) by the intermural development of the corallites.

Alveolites is distinguished (1) by the form and arrangement of the calices, (2) by the fissiparous mode of development, (3) by the presence of mural pores, and (4) by the form and aspect of the corallum.

These genera present the following characters, described from the actual specimens:—

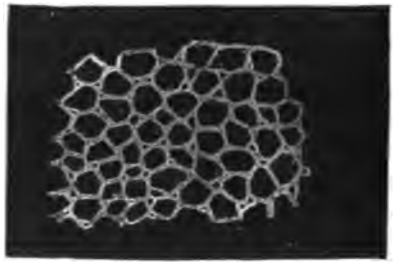
FAVOSITES.



J. Thomson, *del.*

Corallum compound, composed of prismatic corallites, and arranged in superimposed layers. The calices are pentagonal and hexagonal. Tabulæ complete and numerous. The mural pores are abundant and arranged in rows; and the under surface is covered with a wrinkled epitheca, and terminates at a point. The development is intermural, and always at the angle of the parent corallites. The specimens are from the Silurian of Sweden, the Devonian of the Eifel, and from the Carboniferous of Scotland.

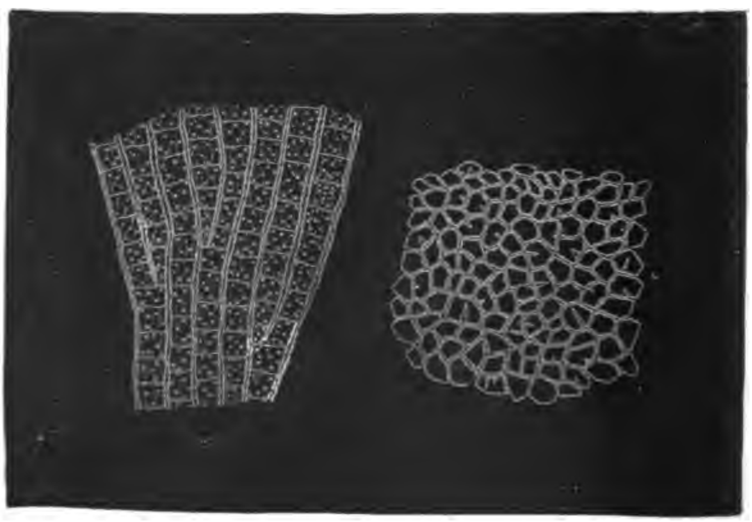
CHÆTETES.



J. Thomson, *del.*

Corallum compound, forming thin, flat, encrusting sheets, and dendriform. Some forms are in small, dome-shaped masses; calices circular and prismatic; development intermural, and always at the angles of the parent corallites. The new cells, which are first seen to be a mere thickening of the intermural space, in the earliest stages are elliptical in outline, but in further development become an elongated depression, and gradually assume a circular outline. In a newly-formed calice the cavity is comparatively shallow, and a transverse tabula is secreted. The tabulæ are numerous and complete. The specimens are from the Silurians of Sweden, the Devonian of the Eifel, and the Carboniferous of Scotland.

ALVEOLITES.



J. Thomson, *del.*

Corallum compound, composed of closely-aggregated spherical corallites, when free from lateral pressure; when affected by lateral pressure they are prismatic, and more or less arranged in superimposed layers.* Calices circular when free from lateral pressure; they are, however, usually oval, triangular, pentagonal, hexagonal, and heptagonal, in the large compound masses where they are more or less affected by lateral pressure. The walls are perforated by irregular mural pores. The increase is by fissiparity. In some instances it is found in irregular, flat sheets, and terminating in a point on the under surface, and frequently attached to foreign bodies and covered with a wrinkled epitheca, while other examples are periform, irregularly hemispherical, and mammilar-encrusting masses. Several of the species are frequently found encrusting the ventral valve of *Productus giganteus.* I have specimens as mere thin encrusting sheets, with a continuous series increasing in height up to fifteen inches.

As regards the affinity and classificatory position of *Alveolites*, the foregoing account of the structure leaves little doubt that the carboniferous species are more nearly allied to the *Alveolites* of Lamarck than they are to any other group. They agree with Edwards and Haime's description in possessing mural pores and by the fissiparous mode of reproduction; and there can be no reasonable grounds for erasing that genus from the carboniferous fauna and placing them amongst the species of a genus that was established nearly thirty years after the creation of *Alveolites.* Indeed, I cannot accept the views of Nicholson and Etheridge (as recorded in the *Transactions of the Linn. Society*, Vol. XIII., p. 367), who place them amongst the *Chætetidæ.* They appear to me, on the contrary, to form a distinct special group, distinguished from *Chætetes*, not only by the more massive aspect many of them assume, but also by the possession of mural pores, the mode of development, the total absence of the small intramural zooids, by their deflected mode of growth, and by the fact that *Chætetes* is usually found in flat, encrusting sheets of no great height. In *Chætetes*, on the other hand, the mode of development is well seen; the young corallites are developed

* The superimposed layers are usually accompanied by impure foreign matter, which has been floated and distributed over the mass, disturbing the continuity of the upward growth of the corallites, and all over where the impurities occur the tabulæ are uniformly deposited, and are more numerous than in any other part of the corallum. This gives rise to the layer-like aspect so frequently seen in this group.

within elongated depressions in the calcareous wall of the parent, and protected by the wall which projects on the surface of the contiguous walls, and when examined by a magnifying glass, they show themselves as elongated warts with a depression in the centre. Indeed, with the mass of illustrations before me (amounting to several hundredweights) as to the structure of *Alveolites* of Lamarck, it is impossible to establish any satisfactory generic relation between this group and *Chætetes*, and this view was the one finally adopted by Milne-Edwards and J. Haime. Were there no other evidence, the possession of perforated walls and priority separates them from the family of the *Chætetidæ*; and I trust that the descriptions given of the genus *Alveolites* are sufficiently distinct to warrant me in retaining the genus as occurring in the carboniferous series. The details coincide closely with the definition of Lamarck, and that of Milne-Edwards and J. Haime, unless in the angularity of the calices. Before we seek to speculate, however, upon the angularity or the non-angularity, we ought to keep in mind that either of these conditions essentially depends upon what part of the corallum Lamarck examined (as before mentioned). If from the summit, then the corallites are seen not to be angular, but they possess the teeth-like processes, or fissiparous division, in a less degree; while a section taken from the lateral margin not only shows the calices to possess the angularity, but there is also a greater increase of the fissiparous projections in the interior of the corallites.

It is within the range of probability that Professor Nicholson's definition of *Alveolites depressa* (E. and H.), *Favosites depressus*, (Fleming), as belonging to the *Chætetidæ*, may have arisen from the accidental mixing of this with forms from other localities. His thirst for distinction has led the professor, in the most erratic manner, to record forms from all the systems of Palæozoic age. It is therefore not improbable that this species may have been one of those which he has so ably described in his elaborate treatise on the "Palæontology of Ontario." Before rashly issuing, not only a description of this species as belonging to the *Chætetidæ*, but also a number of those that are referred to in his work on Tabulate Corals, had he adopted the prudent course of either collecting for himself, or of examining those collected by others, he would have found that the differences are so slight, the gradations so minute, that if each form had been defined as a separate genus from the type of Lamarck, as has in this case been done, such would involve the multiplication of genera beyond recognition. If the professor, with his erudite acumen, had examined a series of sectioned specimens collected from the neighbourhood of Muirkirk, I have reason to believe that he would have ranked many of the varieties as distinct species; indeed, I have no doubt but that some of them would have had new genera created for their reception, as has been so intelligently done in his treatise on the "Palæontology of Ontario." The same series, in the hands of a prudent observer, simply presents variable conditions, so closely linked that it becomes difficult to define the border line in many of the varieties, and he would also have discovered in each and all (when the conditions are favourable) that mural pores can be readily recognised.

Such being the distinguishing characters of the *Alveolitidæ*, I fail to understand why the group should be transferred to the *Chætetidæ*, in which all competent observers have as yet failed to detect mural pores. There are, however, central types, pronounced in their structural details, around which varieties diverge in all directions. In my former paper (*loc. cit.*) I have, by the aid of the originals, brought within a measurable standard, and now further add, the relative proportions of their mural pores. We find that in *Alveolites septosa* (E. and H.), *Favosites septosus* (Fleming), the corallites are about one-third of a line in diameter; that they are from five to eleven lines in length, and that the mural pores are $\frac{1}{16}$ of a millimeter in diameter. In *Alveolites depressa* (E. and H.), *Favosites depressus* (Fleming), the corallites are from a tenth to a fourteenth of a line in diameter, and from three to five lines long; and the mural pores are large and surrounded with a raised lip, and $\frac{1}{12}$ of a millimeter in diameter. In *Alveolites capillaris* (Phillips) the corallites are from a sixth to a tenth of a line in diameter; the tabulæ are about a seventh of a line apart, and the mural pores are $\frac{1}{18}$ of a millimeter in diameter. In *Alveolites Etheridgii* (Thomson) the corallites are from one to three lines in diameter, and from six to ten lines long; the tabulæ are about a seventh of a line apart, and the mural pores are $\frac{1}{16}$ of a millimeter in diameter. All these species are not only found at Asheyburn, Muirkirk, but also in a number of localities throughout the three kingdoms, and these structural details are all more or less constant. In no species have I found them more persistent than in *Alveolites depressa* (E. and H.), *Chætetes hyperborus* (E. and N.). Indeed, this species is the most uncommon and the least variable of the four, inducing me to feel the greater surprise at those eminent authors placing it in another genus, the structural details of which are so distinctly different, and readily recognised by any palæontologist, having even a cursory knowledge of the group. It is true there is no hard and fast line between species and sub-species, which pass by gradations all but imperceptible. But with generic types it is a different matter, and more especially with those genera which the eminent French palæontologists, Milne-Edwards and J. Haime, have so well defined. Of no group have they given a clearer and more lucid definition than those of the *Alveolitidæ* and *Chætetidæ*. Had Prof. Nicholson, instead of plunging from the Carboniferous to the Silurian, and from these to the Devonian, confined his investigations to either, or had he exhausted the evidence so abundantly presented in the Carboniferous system, we might have expected reliable data which would have been more conducive to a knowledge of the palæontology of either of those systems. We cannot expect reliable results from the indiscriminate examination of sections made from a chip here and a chip there, taken from either or all of these systems. Such a palæontological hash is erratic in its origin and leads to confusion and distrust.

While the evidence of the generic and specific distinctions of the four species of *Alveolites* is beyond the region of doubt (with any competent observer), there are varieties lying before me that indicate a deviation from the normal conditions as typified by Lamarck, and by Milne-Edwards and J. Haime, thus demonstrating that in such varieties there is indicated a tendency to evolve from the *Alveolitidæ*, and their mergence through transitional stages to their nearest allies. But whether such modifications are from the *Alveolitidæ* to the type of the *Chætetidæ*, or *vice versa*, is problematical. We can understand, from the numerous illustrations of such modifications, that such varieties do indicate a passage from the normal type, and ultimately assume specifically distinct forms. We do not deny that there are many and important breaks in the continuity of the evidence; that their natural relationship is plainly indicated in the modified forms that have been discovered there can be no reasonable doubt. Whether such modifications have been due to the inherent tendency and the lapse of time, or to the changed conditions of the environments, is (with our present knowledge) beyond the reach of absolute demonstration; yet, in this and allied groups, there is a constant and persistent series of modifications exemplified by distinctions infinitesimally minute, inducing us to believe that when the subject has received the attention which it merits, when the continuity of the chain of evidence is more complete, then, and not till then, will a prudent observer be justified in deleting the deductions of former observers.

In conclusion, I may be permitted to suggest to those who may be desirous of beginning the study of carboniferous corals by means of thin sections, instead of rashly arriving at decisions adverse to those of former investigators, from the examination of mere fragments of specimens, that they should rather section their specimens of the total diameter of the masses. This may involve a great amount of labour and expense, but I am certain that the results will be of the most instructive character. Transparencies lie before me nearly one foot in diameter. In one of these there is evidence that would have delighted the late eminent and careful observer, Mr. Darwin. In several there are indications of the minute inter-zooids that are usually seen in the majority of the species of *Chætetes.* In one specimen from Bristol these minute apertures are so frequent that I was almost induced to regard it as belonging to the latter genus. Upon mature consideration, and reflecting upon the fact that in every group which has been examined by me, there is abundant evidence exemplified, showing a tendency to evolve from, and to merge into, the nearest allied groups, I therefore considered it more prudent, instead of rashly disregarding the deductions of such observers as Milne-Edwards and J. Haime, to lay this specimen aside till I had procured more closely-related evidence regarding it, which I believe will by-and-by be forthcoming, and when we will be in a position to say that the line of demarcation is shadowy indeed, even between genera. I am satisfied that the author who acts differently may live to see the products of his ill-timed labours doomed to find a place in the waste basket. If Professor Nicholson is not now satisfied that I have been able to grasp even the elementary facts, I have other evidence that possibly I may yet ask his leave to publish.

range themselves in groups that travel on divergent lines. We are on historical ground, too, in saying that the original rupture between north-west and south-east was rendered permanent by internal causes due to the growth of an elaborate social and sacerdotal system peculiar to the Asiatic section, and by such external agencies as the inroads of the Tatar hordes from Central Asia, and the spread of Semitic influences from the south-west. Bearing in mind that the oldest names for the outstanding features of the country in Europe are of Celtic origin, and that the Celts are, both in point of locality and civil progress, an outlying, isolated, and diminishing stock, we may safely infer that they were the first to move westwards. All the traditions of the Græco-Latin stock point to an Eastern origin, and that a very remote one. On the other hand, not till the fourth century do the Teutons emerge from obscurity and take a place in literature. They are then on the lower Danube, but driven into the Empire by ruder barbarians on the north. The translation of the New Testament by the Bishop of the Goths, Ulfilas (about 360 A.D.), constitutes, philologically speaking, the Veda of the Teutons. The language of the Goths retains very many of the characteristics of the primitive Aryans, and throws besides invaluable light on the whole subsequent dialectic growth of the Teutonic tongues. The Slavs, having for centuries to maintain a hard contest between their Teutonic brethren on the west of the Sarmatian plain and the Mongol savages of the east, have arisen but slowly out of their primitive barbarism. Their language, however, preserves some singularly interesting archaisms.

As the great schism that has permanently separated the Asiatic from the European groups brings us nearest to the proto-Aryan period, whatever throws light upon the significance of that event serves still further to illustrate the stage of culture which the combined stock had reached. We have seen on what points of material, mental, and moral culture they all agree. It will be important to notice in what respects they differ. Roots will be found to divide in a mysterious way, so that the north-western group, for example, prefers to express the action of milking as stroking, softening (marg-), the south-eastern as drawing (duh-). Similarly the root ar- goes to Europe as ploughing, and remains in Asia as rowing, the Hindoos betaking themselves to another common radical (karsh—to draw) to express this action; while the Sans. kshuma is supplanted in the west by linen, flax. Of more special growths we have the Vedic soma as a sacred beverage remaining strictly in the east, while vinum spreads all over the west. It was probably due to climatic conditions that the Hindoos added to the primitive set of phonetic symbols such new peculiar forms as characterise the Sans. alphabet. But the most striking proofs of an imperfectly-developed common civilisation remain to be noted. For example, whereas the ear for phonetic variations was so developed as to produce a rich flexional system, and perpetuate minute shades of accentuation, the colour sense, as might be expected, was a late growth. The Sans. for colour is varna, literally what covers, and is the same as vellus and our wool. It was also chosen to express caste, a most significant specialisation of its force. But this vagueness in colour-naming is best shown in the case of the metals. Gold is S. hir-anya, hár-ita, Z. zaranya, zairita, Sl. zlŭtu, zelenu, Go. gulth and our gold, Gr. chrusos. These all agree in naming the metal from its colour, the yellow. From the same stem, however, come S. hari, green and Lat. gilvus, flavus, and our yellow; from S. harit, red, Lat. fulvus. The neutral tint of silver is more easily decided; it is S. ra*g*ata, the white, or ra*g*ata hiranyam, white gold, just as in Scotland zinc was called white iron. The Lat. arg-entum has the radical sense, but it is lost in the Teut. dialects. The third metal shows the greatest variations of colour-naming, so much so that it may have been applied to copper, bronze, or iron. It is in Sans. ayas, Lat. aes, Go. aiz. In Ulfilas the apostles are to take no aiz (money) in their girdles. Gr., Lat., and Teut. have developed their words for iron on quite independent lines. When we deal with the names of commodities that are the products of an advanced civilisation, we are in the region of loan-words, interesting as evidence of a very early commerce, and this necessarily complicates the question as to the higher culture of the proto-Aryans. Some of these loan-words are extremely old—sugar-candy, for example, came from India in the remotest times, crystallised on sticks of cane or bamboo. Sugar is the S. carkara = gravel, Pers. shakar, Lat. saccharum, and Gr. with slight change, M.E. sugre. Candy is S. kandha, a stick, and Pers. quandat, quandi (sugared). The word lives in Lowland Sc. as gundy.

The only point that now remains to be discussed is the home of the Aryas. We were long satisfied with locating it somewhere in Western Asia, probably in the region stretching south from the Caspian and along the valley of the Oxus, on the one side reaching up the slopes of the Paropamisan and Hindoo-Koosh, and on the other to the Armenian Highlands. This position gives us, mindful of the saying, *ex oriente lux*, a reasonable centre of development, and accords well with such historical facts as bear on the point. In respect of natural products and climatic conditions it lends itself to the deductions already drawn from the lists of most widely-diffused terms. But a European centre has long been claimed for the Aryan dispersion, somewhere in South Russia, the Danube, the shores of the Baltic, and so on. This theory would make the proto-Aryans spring from the rude builders of the lake-dwellings and the kitchen-middens. It points to the absence of any common word for lion, tiger, elephant, camel, ape, as inimical to any Asiatic source. It says that the only common trees named, birch and beech, are natives of middle Europe not of Asia. Max Müller discusses the whole question, and replies to this argument on its own lines. There is no doubt that the prehistoric condition of middle Europe was unfavourable to the early growth of civilisation. In point of fact, when there at all, it came late and from the south. Dense forests covered a marshy land. The inhabitants must have been confined to the neighbourhood of lakes or of the sea, where alone were the means of easy subsistence. If, then, the dispersion was from such a centre, there ought to be a common word for fish, yet the Sans. matsya, and the Teut. and Celt. fish are from different radicals; common names for shells and shell-fish are entirely absent. The eel is not found in the Black or Caspian Sea, and the name, though from a common root, is of western and later growth. The sea itself ought to, and does, have a common name, but this proves little. In Sans. maru is a desert, literally that which is dead, and Lat. mare and our mere and extensive Teut., Slav., and Celt. forms point to a western development. Why, on this hypothesis, should the European Aryans forget in the east so prominent a natural environment as this? The name for ship, too, is common. It is Sans. nau, Gr. and Lat. naus, A.-S. naca and Ger. Nachen, a skiff, from a root seen in nare, to swim or float. It primarily applies to a boat on a river or lake, and has not spread far in the Teut. dialects. In bird life the crane is not in Sans. but in Zend, because it does not spread further east than Armenia, while the quail appears both in Sans. and Gr. as the returning one. The crane would be new to those who went west, familiar if they went east. Of plants the general term tree as timber is alone common to all. The naming of individual trees is uncertain. There is no definite common term. Bhurja appears in Sans. as the name of a bark used as writing-material. The beech, used as a food, is confined to the North-west. The word is the name of the oak in Greek. The Lat. quercus, again, is the Teut. fora-ha and our fir. But the whole argument from the plant and animal life forgets that there are a flora and a fauna of altitude as well as of latitude, and it was never implied that the proto-Aryans lived anywhere but on the uplands of western Asia where European trees and familiar animals thrive. So that it is not necessary to admit, as Prof. Max Müller does, that the names for lion, tiger, might have been forgotten by those western tribes that left the haunts of the creature. This would be intelligible, for what ceases to be generally used ceases to be named. Thus in the prelatic days in Scotland the lectern was familiar. As Presbyterianism took hold of the people the reading-desk, known for a while as the letterin, was applied to the precentor's desk, and in time was forgotten as Episcopacy became unpopular. The ape and tiger are strictly tropical. The lion is more widely diffused, and the word is said to be an Indo-Europ. one, signifying the raving or roaring one. The camel presents a real difficulty, for Bactria, the home of a well-known variety, is admittedly near the centre of ancient Aria. Elephant is a loan-word with a curious history that shows its Aryan origin. The animal was unknown in the west till brought to Southern Italy by Pyrrhus, though ivory had been spread by trade. The word elephant appears in the Gothic translation of the New Testament. Ulfilas, at a loss to translate the camel-hair coat of the Baptist, uses ulubandus, his Gothic equivalent for elephant. It was the only name for a large eastern quadruped, known to him, that would suit. The word is apparently Semitic, eleph, an ox, but contains a Sans. stem, ibha, with the Heb. article prefixed. The Sans. ibha, strong, powerful, is a common name applied to the animal, and its appearance in the west points to a familiarity with the creature after the Hindoos reached Southern India and to an early traffic by the Arabian Sea in ivory. The result of this line of argument goes to prove that the hypothesis of an original Aryan home in western Asia, though from the nature of the case unsupportable by direct evidence, accounts better for all the facts than any other.

X.—*On the detection of Mural Pores in the Genus Alveolites.* By
JAMES THOMSON, F.G.S., Glasgow, Corresponding Member of the Royal Society of Science of Liège, and Honorary Member of the Royal Ducal Society of Jena.

[Read before the Society, 19th December, 1888.]

IN the March number of the *Geological Magazine*, 1888, Professor H. A. Nicholson contributed an article on the detection of mural pores in thin sections of the *Favositidæ*, and referred to a foot-note of mine in the *Transactions of the Geological Society of Edinburgh*, Vol. V., Part 3., p. 381, in which I stated that the discovery of mural pores in microscopic sections "would be one of the greatest discoveries of modern times;" and also referred to my paper on the genus *Alveolites* of Lamarck (*Proceedings of the Phil. Soc. of Glasgow*, Vol. XIII., Part 1, p. 194, 1881). Prof. Nicholson's remarks are not only misleading, but do not correctly state the facts as given in the latter communication. I therefore feel called upon to reply and to correct the same. The passages in his communication are subjoined:—Page 105. "So far as concerns the genus *Alveolites* (Lam.) in particular, it is unnecessary to criticise the statements contained in the above note, since the note itself contains the plainest proof that Mr. Thomson does not know what the genus *Alveolites* (Lam.) is, and that he is not acquainted with any species of the same. The first point is sufficiently shown by his assertion that 'the type' of the genus *Alveolites* in the collection of Dr. Fleming, as every palæontologist knows, is the familiar *Alveolites suborbicularis* (Lam.) of the Devonian rocks, and is preserved at Paris. The second is equally clear from his speaking of 'the four species of *Alveolites*,' as if there were only four species of the genus, the truth being that 'the four species' to which he refers—namely, *Chætetes septosus* (Flem.), *Ch. depressus* (Flem.) I., *Ch. capillaris* (Phil.), *Ch. Ethe-*

ridgii (Thom.), belong to the genus *Chætetes* (Fisch.), and are not referable to the genus *Alveolites* (Lam.), at all!"*

"As regards the general question involved, in view of all that has been published in recent times, as to the minute structure of the Favositoid corals by Ferd. Romer, Lindström, Schluter, Frech, Foord, R. Etheridge, jun., the present writer, and others, it is difficult to believe that one who professes to have studied Palæozoic corals should speak of the recognition of mural pores in thin sections of *Alveolites* as still unaccomplished,† or of its possible accomplishment as being 'one of the greatest discoveries of modern times.' Even in the days of those great masters, Milne-Edwards and J. Haime, before the method of working by means of thin sections had come into use at all, it was a familiar fact that mural pores could readily be recognised in polished slabs of the Favositoid corals. Mr. Thomson does not appear to have grasped the elementary fact."

In summarising the above, the reader will be led to believe (1) that I do not know the genus *Alveolites* (Lamarck) "or any species of the same;" (2) that I only know of four species of *Alveolites;* (3) that the four species belong to the genus *Chætetes* (Fisch.) and have no relation to the genus *Alveolites* (Lam.); (4) that I have not been able to realise the (said-to-be) fact that mural pores can be detected in thin sections; (5) that mural pores were known to Milne-Edwards and J. Haime; (6) that I have not grasped the elementary facts. As regards the first, second, third, fifth, and sixth points, the best answer that I can offer is to refer to the communication Professor Nicholson mentions—namely, *Proc. Phil. Soc. of Glasgow*, Vol. XIII., p. 194, 1881. A few extracts I subjoin.

* "By 'the genus *Chætetes hyperbolus*,' Mr. Thomson refers, I presume, to the 'species' described by Mr. R. Etheridge, jun., and myself under the name *Chætetes hyperborus.*"

[*Note by Author.*—We did expect that the accurate and learned Professor would have been able to recognise that the substitution of an *l* for an *r* was a printer's error.]

† "Mr. Thomson's disbelief in the possibility of recognising mural pores in thin sections of the Favositoid corals is, it may be noted, of comparatively recent growth; thus, in a paper published in the *Proc. Phil. Soc. of Glasgow* in 1881, Mr. Thomson described and figured what he believed to be mural pores in thin sections of *Chætetes Etheridgii* (Thom.), Sp. A reference to his figure (*loc. cit.*, Pl. I., Fig. 7) will show, however, that in this case the supposed mural pores are represented in the centre of the calcite filling up the visceral chamber of the corallite, and that they are really nothing more than granules of calcite."

As regards the fourth—namely, that I did not realise the fact that mural pores could be detected in thin sections, I state, for once and for all, that in no part of that communication do I mention one word regarding thin sections; consequently, Professor Nicholson's rash assertion is misleading I now venture to assert that possibly I possess as large a series of thin sections of the genus *Alveolites* as is known; they can be measured by many square feet, and in no instance have I detected mural pores in thin longitudinal sections, and, from a careful examination of thousands of examples, I have no hesitation in asserting that to find these perforations in such delicate forms would be one of the greatest discoveries of modern times. Then, as for detecting them in trans verse sections, as indicated by Professor Nicholson—from a much longer experience in the preparation and examination of thin sections than Professor Nicholson can claim,—to accept of such evidence I would regard myself as "rash indeed," well knowing that if a section of coral be ground beyond a certain limit, it is no unusual occurrence to find seeming breaks in the continuity of the structure, which is, therefore, most unreliable evidence to found an opinion upon. I have, however, hundreds of examples of thin transverse sections, in which there are seeming breaks in the walls. These, when carefully examined, however, are found to be the result of fission, which may either be from the extension of the spiniform points from the opposite sides of the corallites, and just preceding their union, and therefore expose a more or less open space at the point of junction; or they may arise from the extension of only one of these spiniform processes, leaving an open space at their union with the wall on the opposite side of the corallite. Of these I have hundreds of examples. From an examination of Professor Nicholson's own plates, I suspect that he has been led to believe that the non-union of the fissiparous processes are transverse sections of mural pores.

As regards the calcite filling the visceral chambers, as he states, and his remark that the mural pores were simply granules of calcite, and that my belief in mural pores is of recent growth—how such an expression could emanate from such an eminent and "accurate observer" is simply surprising. As a reference to my communication on the genus *Alveolites*, 1881 *(loc. cit.)*, indicates clearly that I did know of mural pores, not, however, in thin sections; but in weathered specimens of either of the four species of *Alveolites* from the carboniferous rocks, there is abundant evidence of their presence.

I have also large masses which, when broken, expose in the centre of the mass hundreds of corallites, which, during fossilisation, have been in no way affected by or filled with foreign matter. These not only exhibit the unfilled corallites, but expose the mural pores along the walls in the most perfect condition, which a very careful observer had no difficulty in detecting within the last few hours. Therefore the supposition that I had mistaken granules of calcite for mural pores could only arise through Professor Nicholson's ignorance of the evidence that I do possess, and of which he knows nothing; and I believe that if he had applied the same prudent caution in his examination of the genus *Alveolites* that he indicates in his work on the Tabulate Corals, when describing the genus *Monticulopora* or its allies, p. 276, he would have saved me from referring to such a gross error as the following, namely:—"There is at present no evidence as to the existence of mural pores in *Monticulopora*. Considering the minute size of the tubes and the great difficulty which commonly attends the detection of the apertures (mural pores) in microscopic sections, the non-recognition of pores does not absolutely imply their non-existence."

If my time would permit I am in a position to show that there are mural pores, comparatively large, in the genus *Monticulopora*. Indeed, these are not the only genera that are referred to, and which can be shown to be equally erroneous in their determinations, in his erudite work on the Tabulate Corals.

Regarding my ignorance, I may inform my eminent critic that I not only consulted all the specimens in the museums I had access to in this country, but also the type in Paris; also all the works at my disposal; yea, even Professor Nicholson's elaborate contribution to the "Palæontology of the Province of Ontario," in which he describes no fewer than twelve species of *Alveolites*.

And when in Canada and the United States of America in 1884, I examined all the specimens of the group that my time admitted of, amongst which were some of the species Professor Nicholson had determined and described in the memoir referred to; and I am obliged to state that it would have been more creditable to the author had they been still undetermined, an opinion shared by several well-known palæontologists of that great continent. I will, however, give a few extracts from my paper on the genus *Alveolites (loc. cit.)*, to which Professor Nicholson has referred, believing that what is therein stated will demonstrate that his remarks are not only misleading but are unreliable. For fuller details I beg to refer interested parties to the paper mentioned.

Firstly,—At page 195 I suggest that the different generic and specific names that have been applied to this group may have arisen from the examination of external aspects, and I further state that I have specimens in which the corallites are spherical, semicircular, triangular, pentagonal, hexagonal, and even heptagonal in the same mass,—thus clearly showing that the external aspect was not an infallible guide, either for generic or specific diagnosis.

Secondly,—At page 197 reference is made to the discovery of a specimen in Cunningham Bedland, Dalry, Ayrshire, and subsequently in Charlestown lime quarry, Fifeshire. In each we have mural pores exposed in abundance. The non-discovery of mural pores in specimens from the latter locality induced Prof. Nicholson to delete the genus *Alveolites*, and substitute for *Alv. depressa* (E. and H.) the genus *Chætetes*, and create a new species—namely, *Chæt. hyperborus* (N. & E.). And I have reason to believe that had the learned Professor examined with ordinary care many of the specimens that were procurable, he would have found no difficulty in discovering mural pores.

Thirdly,—At page 198 I briefly refer to the histology of the genus, and point out the reasons adduced by Lamarck, and MM. Edwards and Haime for their definitions of the genus; and at page 199 give a summary of Nicholson and Etheridge's definitions of the genus, and their reasons for substituting the genus *Chætetes* for that of *Alveolites*, that is to say, the absence of mural pores, the erect corallites, and the obliquity of the calices.

Fourth,—At page 200 I state that we have many specimens in which all these conditions are exposed, and, further, that I have submitted these specimens to several of our ablest palæontologists, and that each had found mural pores in all the specimens; and, likewise, that I have a specimen from the Devonian Rocks, Eifel, which so closely resembles some of our carboniferous specimens that it might be mistaken for the latter. Then at page 201 I state that I had failed to find one character in common amongst all the specimens of *Alveolites* and that of *Chætetes*. Again, I refer to the distinctiveness of the generic characters of *Alveolites* and of *Chætetes*, as exemplified in the different modes of reproduction. In order that this should be as clearly defined as possible, I introduced plates, and a summary of the generic descriptions of *Alveolites* and those of *Chætetes;* also a plate showing the distinguishing structural characters of the genus *Favosites*, a genus with which *Alveolites* had been associated by some authors, an error, I believe, arising from the definition of the corallum from the examination of the external aspect. In order that there may be no ambiguity I again introduce the same plates that accompanied that communication (*loc. cit.*), and a *resumé* of the distinguishing characters of each of the three genera.

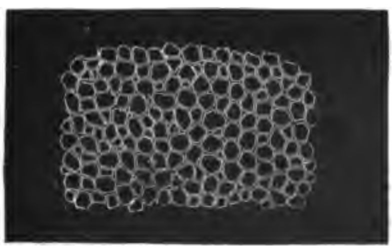
These points may be briefly summarised as follows:—*Favosites* may be readily distinguished (1) by the presence and arrangement of the mural pores, (2) by the mode of development—the carboniferous being intermural, and, in some of the Silurian forms, calicular, and always at the angles of the parent corallites.

Chætetes may at all times be recognised (1) by the flat encrusting sheets and dendriform masses, (2) by the non-existence of mural pores, and (3) by the intermural development of the corallites.

Alveolites is distinguished (1) by the form and arrangement of the calices, (2) by the fissiparous mode of development, (3) by the presence of mural pores, and (4) by the form and aspect of the corallum.

These genera present the following characters, described from the actual specimens:—

FAVOSITES.



J. Thomson, *del.*

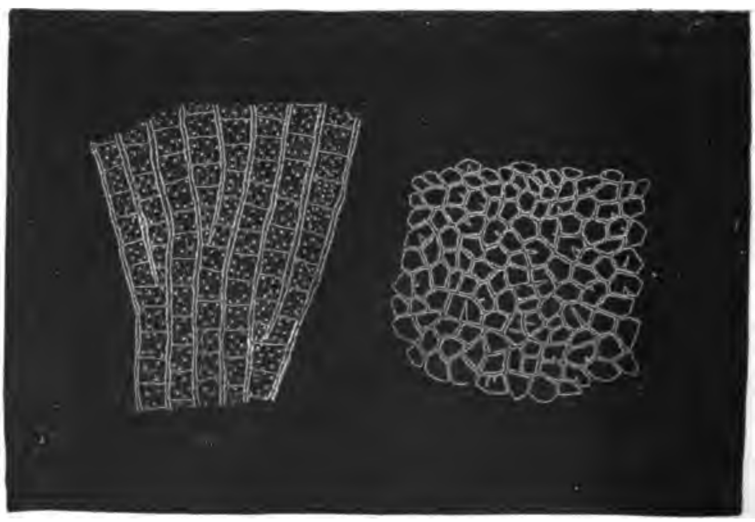
Corallum compound, composed of prismatic corallites, and arranged in superimposed layers. The calices are pentagonal and hexagonal. Tabulæ complete and numerous. The mural pores are abundant and arranged in rows; and the under surface is covered with a wrinkled epitheca, and terminates at a point. The development is intermural, and always at the angle of the parent corallites. The specimens are from the Silurian of Sweden, the Devonian of the Eifel, and from the Carboniferous of Scotland.

CHÆTETES.

J. Thomson, *del.*

Corallum compound, forming thin, flat, encrusting sheets, and dendriform. Some forms are in small, dome-shaped masses; calices circular and prismatic; development intermural, and always at the angles of the parent corallites. The new cells, which are first seen to be a mere thickening of the intermural space, in the earliest stages are elliptical in outline, but in further development become an elongated depression, and gradually assume a circular outline. In a newly-formed calice the cavity is comparatively shallow, and a transverse tabula is secreted. The tabulæ are numerous and complete. The specimens are from the Silurians of Sweden, the Devonian of the Eifel, and the Carboniferous of Scotland.

ALVEOLITES.



J. Thomson, *del.*

Corallum compound, composed of closely-aggregated spherical corallites, when free from lateral pressure; when affected by lateral pressure they are prismatic, and more or less arranged in superimposed layers.* Calices circular when free from lateral pressure; they are, however, usually oval, triangular, pentagonal, hexagonal, and heptagonal, in the large compound masses where they are more or less affected by lateral pressure. The walls are perforated by irregular mural pores. The increase is by fissiparity. In some instances it is found in irregular, flat sheets, and terminating in a point on the under surface, and frequently attached to foreign bodies and covered with a wrinkled epitheca, while other examples are periform, irregularly hemispherical, and mammilar-encrusting masses. Several of the species are frequently found encrusting the ventral valve of *Productus giganteus.* I have specimens as mere thin encrusting sheets, with a continuous series increasing in height up to fifteen inches.

As regards the affinity and classificatory position of *Alveolites*, the foregoing account of the structure leaves little doubt that the carboniferous species are more nearly allied to the *Alveolites* of Lamarck than they are to any other group. They agree with Edwards and Haime's description in possessing mural pores and by the fissiparous mode of reproduction; and there can be no reasonable grounds for erasing that genus from the carboniferous fauna and placing them amongst the species of a genus that was established nearly thirty years after the creation of *Alveolites.* Indeed, I cannot accept the views of Nicholson and Etheridge (as recorded in the *Transactions of the Linn. Society*, Vol. XIII., p. 367), who place them amongst the *Chætetidæ.* They appear to me, on the contrary, to form a distinct special group, distinguished from *Chætetes*, not only by the more massive aspect many of them assume, but also by the possession of mural pores, the mode of development, the total absence of the small intramural zooids, by their deflected mode of growth, and by the fact that *Chætetes* is usually found in flat, encrusting sheets of no great height. In *Chætetes*, on the other hand, the mode of development is well seen; the young corallites are developed

* The superimposed layers are usually accompanied by impure foreign matter, which has been floated and distributed over the mass, disturbing the continuity of the upward growth of the corallites, and all over where the impurities occur the tabulæ are uniformly deposited, and are more numerous than in any other part of the corallum. This gives rise to the layer-like aspect so frequently seen in this group.

within elongated depressions in the calcareous wall of the parent, and protected by the wall which projects on the surface of the contiguous walls, and when examined by a magnifying glass, they show themselves as elongated warts with a depression in the centre. Indeed, with the mass of illustrations before me (amounting to several hundredweights) as to the structure of *Alveolites* of Lamarck, it is impossible to establish any satisfactory generic relation between this group and *Chætetes*, and this view was the one finally adopted by Milne-Edwards and J. Haime. Were there no other evidence, the possession of perforated walls and priority separates them from the family of the *Chætetidæ*; and I trust that the descriptions given of the genus *Alveolites* are sufficiently distinct to warrant me in retaining the genus as occurring in the carboniferous series. The details coincide closely with the definition of Lamarck, and that of Milne-Edwards and J. Haime, unless in the angularity of the calices. Before we seek to speculate, however, upon the angularity or the non-angularity, we ought to keep in mind that either of these conditions essentially depends upon what part of the corallum Lamarck examined (as before mentioned). If from the summit, then the corallites are seen not to be angular, but they possess the teeth-like processes, or fissiparous division, in a less degree; while a section taken from the lateral margin not only shows the calices to possess the angularity, but there is also a greater increase of the fissiparous projections in the interior of the corallites.

It is within the range of probability that Professor Nicholson's definition of *Alveolites depressa* (E. and H.), *Favosites depressus*, (Fleming), as belonging to the *Chætetidæ*, may have arisen from the accidental mixing of this with forms from other localities. His thirst for distinction has led the professor, in the most erratic manner, to record forms from all the systems of Palæozoic age. It is therefore not improbable that this species may have been one of those which he has so ably described in his elaborate treatise on the "Palæontology of Ontario." Before rashly issuing, not only a description of this species as belonging to the *Chætetidæ*, but also a number of those that are referred to in his work on Tabulate Corals, had he adopted the prudent course of either collecting for himself, or of examining those collected by others, he would have found that the differences are so slight, the gradations so minute, that if each form had been defined as a separate genus from the type of Lamarck, as has in this case been done, such would involve the multiplication of genera beyond recognition. If the professor, with his erudite acumen, had examined a series of sectioned specimens collected from the neighbourhood of Muirkirk, I have reason to believe that he would have ranked many of the varieties as distinct species; indeed, I have no doubt but that some of them would have had new genera created for their reception, as has been so intelligently done in his treatise on the "Palæontology of Ontario." The same series, in the hands of a prudent observer, simply presents variable conditions, so closely linked that it becomes difficult to define the border line in many of the varieties, and he would also have discovered in each and all (when the conditions are favourable) that mural pores can be readily recognised.

Such being the distinguishing characters of the *Alveolitidæ*, I fail to understand why the group should be transferred to the *Chætetidæ*, in which all competent observers have as yet failed to detect mural pores. There are, however, central types, pronounced in their structural details, around which varieties diverge in all directions. In my former paper (*loc. cit.*) I have, by the aid of the originals, brought within a measurable standard, and now further add, the relative proportions of their mural pores. We find that in *Alveolites septosa* (E. and H.), *Favosites septosus* (Fleming), the corallites are about one-third of a line in diameter; that they are from five to eleven lines in length, and that the mural pores are $\frac{1}{16}$ of a millimeter in diameter. In *Alveolites depressa* (E. and H.), *Favosites depressus* (Fleming), the corallites are from a tenth to a fourteenth of a line in diameter, and from three to five lines long; and the mural pores are large and surrounded with a raised lip, and $\frac{1}{12}$ of a millimeter in diameter. In *Alveolites capillaris* (Phillips) the corallites are from a sixth to a tenth of a line in diameter; the tabulæ are about a seventh of a line apart, and the mural pores are $\frac{1}{18}$ of a millimeter in diameter. In *Alveolites Etheridgii* (Thomson) the corallites are from one to three lines in diameter, and from six to ten lines long; the tabulæ are about a seventh of a line apart, and the mural pores are $\frac{1}{18}$ of a millimeter in diameter. All these species are not only found at Asheyburn, Muirkirk, but also in a number of localities throughout the three kingdoms, and these structural details are all more or less constant. In no species have I found them more persistent than in *Alveolites depressa* (E. and H.), *Chætetes hyperborus* (E. and N.). Indeed, this species is the most uncommon and the least variable of the four, inducing me to feel the greater surprise at those eminent authors placing it in another genus, the structural details of which are so distinctly different, and readily recognised by any palæontologist, having even a cursory knowledge of the group. It is true there is no hard and fast line between species and sub-species, which pass by gradations all but imperceptible. But with generic types it is a different matter, and more especially with those genera which the eminent French palæontologists, Milne-Edwards and J. Haime, have so well defined. Of no group have they given a clearer and more lucid definition than those of the *Alveolitidæ* and *Chætetidæ*. Had Prof. Nicholson, instead of plunging from the Carboniferous to the Silurian, and from these to the Devonian, confined his investigations to either, or had he exhausted the evidence so abundantly presented in the Carboniferous system, we might have expected reliable data which would have been more conducive to a knowledge of the palæontology of either of those systems. We cannot expect reliable results from the indiscriminate examination of sections made from a chip here and a chip there, taken from either or all of these systems. Such a palæontological hash is erratic in its origin and leads to confusion and distrust.

While the evidence of the generic and specific distinctions of the four species of *Alveolites* is beyond the region of doubt (with any competent observer), there are varieties lying before me that indicate a deviation from the normal conditions as typified by Lamarck, and by Milne-Edwards and J. Haime, thus demonstrating that in such varieties there is indicated a tendency to evolve from the *Alveolitidæ*, and their mergence through transitional stages to their nearest allies. But whether such modifications are from the *Alveolitidæ* to the type of the *Chætetidæ*, or *vice versa*, is problematical. We can understand, from the numerous illustrations of such modifications, that such varieties do indicate a passage from the normal type, and ultimately assume specifically distinct forms. We do not deny that there are many and important breaks in the continuity of the evidence; that their natural relationship is plainly indicated in the modified forms that have been discovered there can be no reasonable doubt. Whether such modifications have been due to the inherent tendency and the lapse of time, or to the changed conditions of the environments, is (with our present knowledge) beyond the reach of absolute demonstration; yet, in this and allied groups, there is a constant and persistent series of modifications exemplified by distinctions infinitesimally minute, inducing us to believe that when the subject has received the attention which it merits, when the continuity of the chain of evidence is more complete, then, and not till then, will a prudent observer be justified in deleting the deductions of former observers.

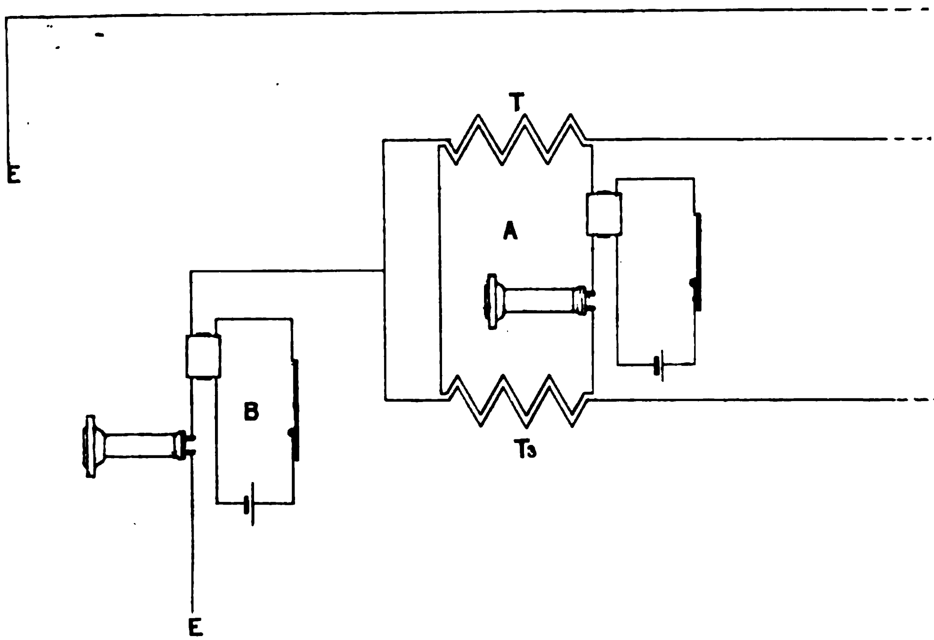
In conclusion, I may be permitted to suggest to those who may be desirous of beginning the study of carboniferous corals by means of thin sections, instead of rashly arriving at decisions adverse to those of former investigators, from the examination of mere fragments of specimens, that they should rather section their specimens of the total diameter of the masses. This may involve a great amount of labour and expense, but I am certain that the results will be of the most instructive character. Transparencies lie before me nearly one foot in diameter. In one of these there is evidence that would have delighted the late eminent and careful observer, Mr. Darwin. In several there are indications of the minute inter-zooids that are usually seen in the majority of the species of *Chætetes.* In one specimen from Bristol these minute apertures are so frequent that I was almost induced to regard it as belonging to the latter genus. Upon mature consideration, and reflecting upon the fact that in every group which has been examined by me, there is abundant evidence exemplified, showing a tendency to evolve from, and to merge into, the nearest allied groups, I therefore considered it more prudent, instead of rashly disregarding the deductions of such observers as Milne-Edwards and J. Haime, to lay this specimen aside till I had procured more closely-related evidence regarding it, which I believe will by-and-by be forthcoming, and when we will be in a position to say that the line of demarcation is shadowy indeed, even between genera. I am satisfied that the author who acts differently may live to see the products of his ill-timed labours doomed to find a place in the waste basket. If Professor Nicholson is not now satisfied that I have been able to grasp even the elementary facts, I have other evidence that possibly I may yet ask his leave to publish.

VI.—Notes on Telephony on Long Lines. By D. Sinclair, Engineer, National Telephone Company.

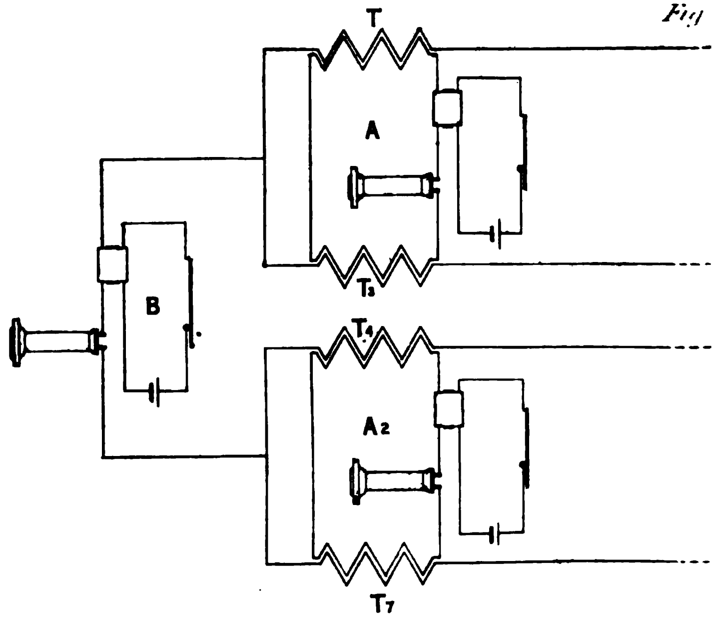
[Read before the Society, [illegible] February, [illegible].]

MULTIPLEX T…

Fig



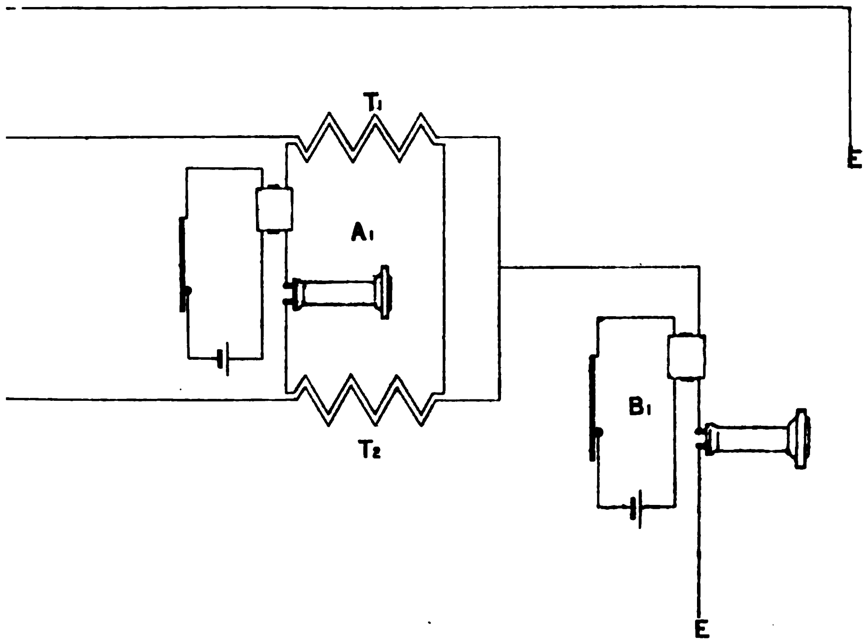
Fig

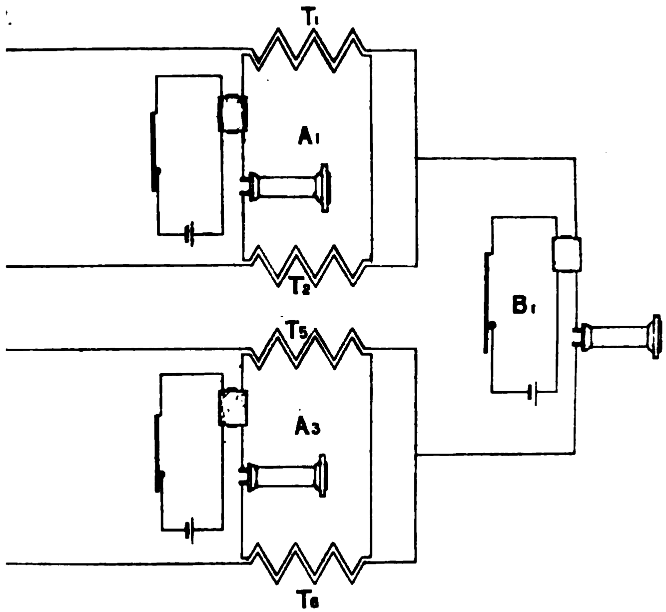


LEPHONY.

Plate. III.

1.





Mach

working it means that one cannot speak between Glasgow and London on an ordinary iron telegraph wire because of it. Copper wires are therefore used for all long lines, as they have comparatively little self-induction.

It is now well known that the form of the conductor is of the utmost importance when used for carrying very quickly alternating currents, such as those of the telephone. Professor Hughes has very clearly shown that an *iron* wire, made up of many strands, has less self-induction than an ordinary copper wire of the same resistance.

At this point I am treading on very much-disputed territory, some authorities holding that this self-induction interferes with or hinders telephonic currents on long iron wires, while others maintain that this same self-induction actually helps the telephonic current along the wire; still, the practical results are as I have stated them, and if anything requires changing it is the scientific ideas and the names given. Experience has shown what actually takes place, which is in compliance with a law formulated by Sir William Thomson in connection with the electrical carrying-power of deep-sea cables. Experience has to prove what results will accrue from the use of stranded, in place of ordinary, iron wire. There is no doubt whatever that it is better, but its comparison with copper has yet to be tried practically.

Now we see that not only must the more expensive copper wire be used, but, in order to overcome the second-mentioned effect of induction, it has to be doubled, thus adding largely to the cost of long telephone lines. This doubling of the wires overcomes the effects of induction. At Fig. 1, Plate III., there are shown one single line, E, E, and one double or loop line, T, T^1, T^2, T^3. Now, if a current of positive electricity is sent along the single wire, an instantaneous current of opposite nature is, at the moment of connection, generated in the other wire; but, as both halves of the loop are equally affected at the same moment, no effect takes place at the telephone, A and A^1, in circuit at either end, from the well-known fact that two electrical currents of a like nature oppose each other and produce no resultant effect.

If, however, the loop is changed into the form of a circle, the part of it nearer to the first or disturbing wire will be more affected than the other; therefore, before "zero-potential" takes place an impulse occurs at the telephone to prevent this inductive effect.

It is necessary in practice so to arrange the loops that at all times both sides of them will be equally acted upon by being at the same distance from the influencing wire. The insulation must be equal throughout both sides of the loop. It does not follow that the insulation must be perfect—it may vary from 100 to 1 megohms per mile, while no difference takes place as regards the induction.

The case is different, however, if the insulation is lowered at any one point by, for instance, a branch of a tree touching the wire and causing a leakage to earth. This creates a lower potential at this particular point, and all currents of a higher potential reach it. In doing so, as before mentioned, they pass through the telephone and cause inductive disturbances, so that a loop or metallic circuit must, in order to be perfect, be entirely free from earth. I have considered it necessary to explain this point particularly, because I have noticed that in America and elsewhere, when the duplexing of telephone lines has been described, the metallic loops were connected to earth. Immediately this is done they lose their value as loops or metallic circuits, and any other telegraph or telephone wires in their vicinity would affect them in exactly the same manner as if they were single wires.

The distance that single wires must be apart ere they cease to trouble each other is great, certainly greater than can be well accounted for on any grounds of reasoning with known electrical laws. Mr. Preece gave out at one time as the result of experiment that the breadth of our country was not sufficient to separate wires so that they would be entirely unaffected by each other; but I believe that this statement has since been recalled. What is well known in practice is that the breadth of a wide road of from 40 to 50 feet is not sufficient to separate a telephone from the evil effects of a telegraph line carrying heavy and quickly-changing currents. It is generally understood that the inductive effects between the wires take place through the air; but it is somewhat difficult to imagine this inductive field, surrounding a wire carrying an ordinary electric current which extends around it to a distance of 50 feet, and especially so when we know that a large portion of the space influenced is taken up by the earth. The height of the wires from the earth is only about 24 feet, therefore some other explanation of the fact than that ordinarily accepted is necessary; and I am of opinion that, inasmuch as each pole has an earth wire, which, entering the ground on each side of the road at every 70 yards for three or four miles, establishes through the earth the connection resulting in what is known to us as induction. This is, however, rather a digression from our subject.

We have now seen that in no way should any earth connection be made to loop-circuit wires. Therefore any arrangement for multiplexing should be such that the earth will not be used in any way.

In the drawings at Fig. 2, two loop-circuits are shown, with a telephone set in both ends of each loop at A and A^1, and A^2 and A^3. A set, B and B^1, are at each end connected between the loops. Speaking can be carried on, first, between A and A^1; second, between A^2 and A^3; third, between B and B^1—all at the same time, and without any interference arising between them, and without taking away from the loops their qualities for overcoming outside inductive effects.

Let us first suppose the two sets, B and B^1, Fig. 2, speaking to each other. The path of the current starts from one side of the instrument, B, and goes through the upper loop, dividing equally between the two wires composing it. It passes through translators T and T^1, reaching translators T^2 and T^3, then proceeds through telephone set B^1, and returns in the same manner through the lower loop and the translators to the opposite side of the telephone, B, from which it started, and so completes its circuit.

While this is taking place none of the telephones in the loops at A, A^1, A^2, and A^3 are in any way affected, because, when the current arrives at T and T^3, each of these translators induces a current of equal strength in the circuit of telephone set A from opposite sides. The result, as is well known, is that they neutralise each other, and produce no effect at the telephone.

The results are the same at A^1, A^2, and A^3, so that none of them is in any way affected. In order that this may be so, the wires must be of equal resistance and insulation. Each one of a pair of the translators must be exactly alike and produce equal effects, though it is not necessary for all the pairs to be alike.

It will likewise be seen at Fig. 2 in the drawing, that either of the two sets A and A^1, also A^2 and A^3, have their circuits complete in the metallic loop in both cases. Currents set up by A speaking to A^1, after traversing the translators and loop wire, meet at the points where the connections are led off to B and B^1 and for currents set up in the loop circuit. In this way these points are at zero-potential, and, consequently, B and B' are unaffected by these currents, and are free to speak, as previously explained. The two sets of telephones in the other loop act in precisely the same manner.

It will now be seen that with two loops, making four wires, three sets of telephones can be wrought without causing any interference between them. The arrangement, however, requires the means of regulating the iron cores of the translators, so that each wire of a pair will be equally affected by currents between B and B'. It is likewise necessary that all the wires should be perfect, and of equal insulation. The large number of translators has a tendency to weaken the speaking, but when shunted with condensers of the proper capacity, this drawback is partly overcome.

There is another method of multiplexing loop lines by using resistance coils in the same position as that occupied by the translators in Figs. 1 and 2, and joining the wires from telephones in the position of those shown at A, A^1, A^2, and A^3, direct on to the loop, thus producing a "bridge" arrangement. Fitted up in this way they have been tried with fairly good results in this country. Nothing has as yet been done other than on a small scale; but with condensers which will help to overcome the evil effects of the translators, and on wires of comparatively low resistance, there is no reason why this method of getting greater value out of loop-circuit telephone wires should not be largely used in time to come.

XII.—*Agricultural Education in this Country and Abroad, with special reference to Germany.* By C. M. AIKMAN, M.A., B. Sc., F.R.S.E., Lecturer on Agricultural Chemistry, West of Scotland Technical College.

[Read before the Society, 6th February, 1889.]

IT may sound a somewhat trite remark, but it is nevertheless true, to say that we live in an age of progress. There are few industries at present that do not afford unmistakeable traces of having been more or less affected by this progressive tendency. Too many, alas, find it rather too progressive for their prosperity, and would fain be restored to the "good old times" when the world moved more slowly, and everything was not constantly in a state of flux.

Agriculture, undoubtedly, belongs to this latter class, and it may be pardoned, to a certain extent, if it does complain somewhat bitterly of the present evil days on which it has fallen, for probably no industry has suffered so keenly from this progressive tendency and from altered outward conditions as this most ancient and, in a sense, most important of all human arts.

It has been, and still is, passing through a transition period, in which old customs, old systems, old ideas, and, perchance, some old prejudices are being one by one abandoned—abandoned, it may be, reluctantly, and in many cases only after a hard struggle, but nevertheless most surely abandoned—in favour of newer and, in the opinion of many, less congenial customs and theories. Now, however necessary and wholesome it is for all industries, to pass from time to time through such periods of transition, periods in which they may be readjusted to suit altered outward conditions, it is by no means pleasant, it will be admitted, for those whose lot it is to live during such transition periods and personally to suffer on behalf of the future welfare of the industries in which they are engaged.

Under this category may be placed all those whose misfortune it has been to be directly interested, either as tenant-farmer or landed proprietor, in agriculture during the last ten or twenty years. It would be idle for me to attempt to explain here the cause or causes which have led to this depressed state of agriculture. Even if I felt myself competent to do so, which I must at once admit I do not, it would occupy so much time that the subject of this paper would stand a small chance of receiving much attention.

Many things which are obvious to all have undoubtedly contributed towards bringing about the present state of agricultural depression, and each writer on the subject has some pet theory in which he thoroughly believes, and which he would fain persuade his readers affords the key to the whole problem. The subject is undoubtedly an interesting one and of great importance. What makes it especially hard for agriculture is that it is an industry whose very nature it is to resist rapid changes, and which lends itself very unwillingly to readjustment. Other industries are so much more quickly readjusted that they feel it less severely. This may account for the fact that agriculture has been the pre-eminent sufferer in this depression.

But however much agriculturists merit the sympathy of all, it is idle for them to cry over past or present misfortune, unless they take steps to do what is in their power to avert it in the future; and while I shall not attempt to explain the cause or causes of the present depression of our agriculture, I shall now bring before your attention the consideration of a subject which I venture to think may have no inconsiderable influence for good on its future prosperity.

The question of *agricultural education* is one which is only now coming prominently to the front in this country, for, while the important influence which the introduction of a thorough and widespread system of agricultural education is calculated to exert on the prosperity of our national agriculture has been long recognised by our most advanced agriculturists, it is only within this last year that public opinion on the subject has been strong enough to warrant Government taking any important action. A step, and an important step, has however now been taken, and we have been promised a Government Agricultural Department, one of whose duties it may fairly be inferred will be the organisation and development of agricultural education in this country; while as an earnest—and only an earnest, let us hope—of what we may expect in the future, a grant of £5,000 has been voted by Parliament towards fostering the educational movement.

Under these circumstances, the present may be considered a peculiarly suitable time for bringing before your notice a brief review of the various systems prevalent in other countries, as well as the little we have as a country already done and are doing in this matter, with a view of comparing them and seeing how far we may imitate, with profit to ourselves, the examples of those countries which are admittedly in advance of us in this department.

Before proceeding, however, it may be well to clearly define what the subject of agricultural education is. The subject of agricultural education is, then, the *science of agriculture;* at any rate, it is in this paper treated as such. I am quite aware that in so defining it I may be charged with making my definition too narrow, for it may be objected that it has also to do with the practice. This in a sense is quite true, and in many countries the practical side of the subject is not overlooked, as witness the existence of farm schools such as at present exist in France, as also dairy schools where the students are not only instructed in the science or principles of their art, but also in its practice: they are not only taught theoretically how to make good butter, but are also practically shown the way. Such schools are of enormous importance and cannot be too highly valued; but while this is so, instruction of such a practical nature will only be capable of yielding its highest results when it is *preceded* by theoretical instruction.

Instruction of a practical nature, furthermore, would not admit of a wide-spread application such as a national system of agricultural education would demand. The art of an industry requires a long time before it can be acquired; its *science*, on the other hand, admits of a very much shorter period of study. The one may be regarded as the work of a lifetime, the other falls under the head of what is called "education," and admits of being acquired during the period of life devoted to educational purposes. This question of the practical nature of agricultural education is simply a particular case of the wider question, —namely, the practical nature of technical education. Technical education, as commonly understood, is not the direct teaching of a trade or art, but the teaching of the scientific principles which underlie that trade or art, with the special view of showing their bearing from an industrial or manufacturing point of view. It is true that we have schools where the practice of a trade or handicraft is actually taught. Such schools might perhaps be fairly called technical schools if it were not that the phrase is already used for schools of another nature; as it is, they are generally distinguished as "trades'" or "handicraft" schools.

Now, while practical agricultural schools such as those devoted to a special department of agriculture, as, for example, dairy schools, are undoubtedly of the highest economic value to the agriculture of a country, and ought to be encouraged as much as possible, it is obviously impossible that such schools could alone fulfil the demand for a national system of agricultural education. Such schools, for one thing, besides requiring very much more money to work them, would necessarily be available only to the few; and, while it is greatly to be wished that we had many such schools, it might become a question whether they would be in the highest sense truly economic. If, however, we regard as the subject of agricultural education the science or principles of agriculture, then it will be seen that it admits of theoretical instruction, and has an important claim to be ranked among the technical sciences, if we may so call them.

Having given now my reasons for believing that a national system of agricultural education must be, in the main, of a theoretical nature, and be based upon the principle that its subject is the science of agriculture and not the practical teaching of its practice, let me proceed to show more in detail what the science of agriculture really is, and why it is only of late years that it has come so prominently to the front.

In a sense, it is true, the science of agriculture is as old as its practice. The first agriculturist who tilled his land and sowed his seed in the belief that in due time he would reap his harvest, must be credited with the possession of a science or theory—of only a very rudimentary kind it must be admitted—of his art. The very act, in short, implies the possession of such a science. So gradually this rude science would grow with the progress of time, each generation of farmers adding the sum of their experience to the whole. Two things, however, militated against the advance of this knowledge in the past. The one was the fact that there was scarcely any provision made for preserving this knowledge—the outcome of experience, and thus of very great value—beyond the method of verbal communication, such as would prevail in the case of father and son. Experience, therefore, which had been obtained by keen observation, instead of being permanently recorded and made known to the world, and compared with other knowledge similarly obtained, was too often permitted to die with its possessor, or, at best, pass on to a single individual. The other reason was the difficulty, or rather impossibility, of interpreting in a scientific way this experience, from the ignorance of the natural sciences which alone afforded the key of explanation. As these natural sciences are themselves only the product of modern times, it follows that it is only lately that agriculture has possessed a science worthy of being so called. It is only within late years that it has become more than a mere collection of empiric rules. Even now our knowledge is still probably in its infancy. We are, notwithstanding, in possession of a mass of important facts, which may well constitute it a science worthy of a place among other technical sciences. Of the sciences on which the science of agriculture may be said to be founded, the most important are undoubtedly chemistry, geology, mineralogy, botany, zoology, and animal physiology.

The important bearing which chemistry has had on the advance of modern agriculture requires, I think, no exemplification here. I may simply be permitted to say that there is scarcely any operation not purely mechanical which the farmer is called upon to perform that is not based upon chemical laws, and demands for its rational explanation the aid of chemistry. What has been done for agriculture by the chemist I need not dwell on; it is sufficient to mention the names of De Saussure, Sir Humphrey Davy, Boussingault, Liebig, Lawes, Gilbert, and Voelcker to illustrate the point.

The importance of geology and mineralogy must, of course, be obvious to all, if we reflect for a moment that the soil may be regarded, to a certain extent, as the raw material out of which the farmer has to manufacture his crops. The sciences which afford him the explanation of the origin and nature of soils must consequently be of very great importance to him in his practical work.

Of the importance of the sciences which are now generally grouped together under the title of biological science—namely, botany, zoology, and animal physiology, I need also hardly speak. The value of a knowledge of botany to the practical agriculturist is daily, even in this country, being more and more recognised, especially as dairy and pasture farming is so much on the increase. For this reason also zoology and animal physiology are of growing importance.

Of veterinary science I need also scarcely speak, as its importance to the agriculturist must be obvious to all.

In addition to these sciences, there are, of course, other sciences which in the case of advanced education on this subject ought most certainly to be included. Of these I may mention rural law, land surveying, and political, or, more strictly speaking, rural economy. As these probably, however, are sciences which would scarcely be suited for elementary instruction, or at any rate so well, as those already mentioned, they could only be taught at higher institutions, such as the Universities.

The science of agriculture may be therefore defined as the science which has for its object the interpretation of the various operations of agriculture by means of the aid of these other sciences, and the ideal course of agricultural education would be a course which included a series of lectures on these different sciences; the same being treated in what I may call their technical sense, that is to say, with especial relation to agriculture.

Having now defined what I consider to be the subject of agricultural education, permit me to draw your attention for a few moments to the condition of agricultural education in one or two foreign countries.

I shall begin with Germany, and this for two reasons: first, because it is the country which possesses at this present time the most elaborate and wide-spread system of agricultural education of any country in the world; and, secondly, because I had the opportunity of visiting last summer several of its most important agricultural educational centres.*

The movement which has resulted in the present elaborate system dates back to the middle of the present century, and may be said to have owed its greatest impetus to Liebig. From the publication of that distinguished chemist's works in 1840 till the present day, the great importance of agricultural education has been increasingly recognised in Germany. The so-called "fatherly" tendency of the German government is nowhere more strikingly exemplified than in the enormous grants annually devoted by the state towards the upkeep of agricultural colleges and schools.

* For a fuller and more detailed account of German Agricultural Education and Experimental Stations I would refer those especially interested in the question to my paper in the "Journal of the Highland and Agricultural Society of Scotland for 1889" (Wm. Blackwood & Sons).

It cannot be denied that the success of the German agricultural schools is to be ascribed, to some extent at least, to the military conscription system of the country. The privilege of serving one year instead of three is open to those who have passed certain examinations. By attending the higher agricultural schools farmers' sons are enabled to qualify for this right. A very powerful stimulus, it will be thus seen, exists among the farming classes to attend the agricultural schools. These are of different kinds, and may be broadly divided into the following six classes:—

1. Agricultural Institutes (generally forming a distinct Faculty of a University).
2. Agricultural schools of the intermediate class (*Landwirthschafts-Schulen*).
3. Agricultural schools of the second grade (*Ackerbau*).
4. Winter schools and evening schools (the so-called Improvement Schools).
5. Special schools—for example, dairy, shoeing, etc.
6. Travelling Lecturers (*Wanderlehrer*), who are supported by agricultural societies, and who deliver lectures in towns and villages, at the request of local societies and farmers' clubs.

With regard to both the intermediate and lower class agricultural schools, it must be noted that agriculture does not form the sole subject of study, but constitutes only a part of the curriculum, other subjects being taught as well.

The agricultural institutes are, as I have already stated, generally connected with a university, of which they constitute a faculty. They are all plentifully equipped with professors and lecturers, and offer to students of agriculture a most elaborate curriculum, embracing such subjects as chemistry, natural history, land-surveying, agricultural engineering, rural economy and law, gardening, animal physiology, botany, physics, entomology, &c.

Of these the Agricultural High School of Berlin, forming a part of the Berlin University, is distinctly first in importance. The buildings which constitute this school are large and handsome, the main one being some 240 feet long by 180 feet deep. The central hall forms the museum of the college. It is the most extensive agricultural museum in the world, and contains a most complete collection of agricultural implements of all kinds. I was informed that nearly all the implements were lent by the makers, and that they were constantly being removed and replaced by those of more modern structure. The museum contains, in addition to agricultural implements, magnificent botanical, zoological, and mineralogical collections.

The initial cost of the Berlin Agricultural High School amounted to over £130,000. It is splendidly equipped with laboratories, &c. Considering the nature of the instruction the fees are extremely moderate. In view, however, of the number of students attending the school it must be confessed that the benefits seem to be rather out of proportion to the expense; the annual government grant being probably not much under £9,000. Of these institutions, of a first-class nature, there are some twelve or thirteen in Germany, many of them being attached, as I have said, to the universities; those of Bonn, Halle, Göttingen, Königsberg, Kiel, Breslau, Leipzig, Giessen, and Jena belonging to this class, while of those separate from a university undoubtedly the most important is that of Hohenheim. This latter may be taken as a good type of the others. Accordingly, a short description of it may serve as an illustration of this class of agricultural colleges.

Hohenheim is in the kingdom of Würtemburg. It is under the control of the Minister of State for ecclesiastical and educational affairs, and is worked on the principle of the combination of practice with science, and has attached to it a farm of about 760 acres. It is well equipped with professors and lecturers, numbering among the former the distinguished experimentalist, Dr. Emil von Wölff. Its course extends over two years, each consisting of two sessions, winter and summer, and the students being for the most part residential. The fees are also extremely moderate, as is the case in most of these colleges—almost the entire expense being borne by the State. Although Würtemburg is comparatively a small kingdom, numbering some two millions of a population, it has, in addition to this large academy, several other agricultural colleges, in addition to schools of a more elementary nature, such as are to be found all over Germany, and to which I shall refer immediately. I may incidentally mention that the total amount spent by this small kingdom on agricultural education amounts to close on £11,000 per annum. On this point, allow me to quote from a paper which has recently appeared in one of the agricultural journals, by Mr. Wm. Somerville, B.Sc.:—"What must strike one chiefly is the fact that this little kingdom of Würtemburg, not more than half the size of Yorkshire, whose exact whereabouts the average Englishman may be excused having some difficulty in determining, is so thoroughly alive to the importance of its agricultural interests that it dwarfs England's somewhat feeble efforts into absolute insignificance. Averaging the difference, as regards both areas, between Würtemburg and Britain, and then multiplying what the former country spends upon its agricultural education by the number thus found, we arrive at the result that, if our own country acted in the same generous way, it would expend yearly £184,433 on education in agriculture alone. If we take the sum which Würtemburg spends on other agricultural matters—namely, £14,130, and treat it in the same way, we find that, to be equally careful of her agricultural interests, Britain should spend £240,210. Adding these sums together, we get £424,643 as the amount which should find its way every year into channels leading directly to foster agriculture in this country."

So much then for this first class of agricultural colleges. Of the second or intermediate, *Landwirthschafts-Schulen*, we have schools not entirely devoted to agricultural education, but at which agricultural science forms a prominent feature. They occupy a position intermediate between the *Gymnasium* or classical school on the one hand, and the *Real-Schule* or modern school on the other. Of these there are some sixteen at present, each kingdom having at least one, some two. Here the education is of a theoretical nature.

We come now to the third class of schools, those affording a lower agricultural education, the so-called *Ackerbau-Schulen*, which are very much more plentiful on the whole, one province alone possessing over thirty. Some are in connection with the intermediate schools and act as feeding schools for them, the others being of a more practical nature. My time will not permit me to do more than merely mention the other classes of schools—namely, the so-called winter schools, which only exist for a short period of the year, and consist of little more than evening lectures, these being primarily intended for those practically engaged in agricultural pursuits; the travelling lecturers, *Wanderlehrer*, who travel about from place to place delivering before agricultural societies papers of a more or less practical nature; and, lastly, the large number of agricultural schools for special subjects, such as dairying, forestry, bee-keeping, &c. In the Appendix to this paper will be found tables containing statistics as to the number of these various schools, from which it will be seen that the total number amounts to several thousands.

Before leaving the subject of German agricultural education permit me to refer briefly to the large number of magnificently-equipped experimental stations. The influence which the existence of these institutions must exert on the agricultural education of the country cannot be too highly rated. In some countries their establishment has preceded that of the more strictly educational institutions, while in others it has followed them. Of these experimental stations there are at present in Germany some seventy, all of them engaged in useful work, both in the shape of original research and of a more practical nature as *control stations;* that is to say, in the analysing of manures, seeds, and feeding-stuffs. A complete list will be also found in the Appendix.

In France the system of agricultural education is of a more practical nature than that of Germany. The history of the movement dates back as far as 1763. Not much progress, however, seems to have been made until the early part of this century. The institution which stands at the head of French agricultural colleges is the National Agricultural Institute in Paris, which was first started—although it has passed through several changes since then—in 1848. Like the Berlin High School, it is thoroughly equipped with a full staff of eminent professors. The subjects taught include chemistry, mechanics, mineralogy, zoology, botany, physiology, meteorology, rural economy, geology, arboriculture, agricultural engineering, etc.

The expense of keeping up this institution is naturally considerable. This, it has been calculated, amounts to little short of £100 per student per annum. The students include those who aspire to positions in the Government department of agriculture, professors of agriculture in the different schools throughout the country, directors of experimental stations, sugar manufactories, distilleries, &c., large tenant farmers, &c. The grant for this institute in 1882 amounted to over £10,000, the amount received in fees being only some £720. The staff consists of over twenty professors.

In addition to this splendidly-equipped institute, France possesses three other schools at which agricultural education of a high order is taught. These are called "regional" schools, the most important being that of Grignon. They are all supported entirely by the State, that of Grignon costing about £7,000 a year. The education at these regional schools is both of a theoretical and practical nature.

We have next to these regional schools the so-called "practical" schools, which have large farms attached to them. Here the instruction is mainly practical. The students live in the school, the course being of two years' duration.

The third and lowest class of schools are the "farm schools," in all from twenty to thirty in number. Here the pupils, who consist chiefly of the small farmer or even ploughman class, may be regarded as apprenticing themselves to the director of the school for a period varying from two to three years. These schools are also supported by the State. In addition to these there are certain others, which are devoted to special subjects, just as in Germany, such as forestry, drainage and irrigation, dairying, &c.

Lastly, there are what are called departmental professors of agriculture. These professors lecture in so-called normal schools, which, like those in this country, are schools devoted to the training of teachers. Their salaries are defrayed by the State. Of these departmental professors there is an ever-growing number, the intention of the government being that each department of the country should possess at least one of these professors. I may add that France, like Germany, possesses a number of agricultural experimental stations; their number, however, is not much more than one-third of those in Germany, while the nature of their work is very largely of a purely practical order, comparatively little work of a research nature being undertaken.

In conclusion, contrasting the system of education in Germany and in France, we see that that of the latter, while of a distinctly more practical nature, is by no means so elaborate or wide-spread as that of the former.

Of other continental countries, Denmark, Belgium, and the Netherlands may be mentioned as occupying a foremost place as possessors of a developed system of agricultural education. This has already borne fruit in Denmark, as all are aware. The movement began in that country about the beginning of this century, when a professor of agriculture was appointed in the University of Copenhagen; and since then the system has been gradually extended. It may be divided into two classes: the first advanced and almost of a purely theoretical nature, the second almost wholly practical. The development of dairy instruction, resulting in the production of butter and other dairy produce of an exceptionally excellent quality, is, alas, too well known in this country. The importation of Danish butter into our home markets in such large quantities has had at least one good effect, for it has helped to a no inconsiderable extent to bring prominently before the public the great necessity of similar dairy instruction in this country. The valuable work done by the Royal Agricultural Society of Denmark in the promotion of higher agricultural interests ought not to be omitted in any account of Danish agricultural education.

According to Mr. Jenkins' report, published in 1884, the Danish Government spent at that time about £11,000 per annum in the promotion of agricultural education.

With regard to Belgium and the Netherlands, it must suffice to say that their system resembles that prevailing in France. They each possess one first-class institution, being, respectively, at Gembloux for Belgium, and Wageningen for the Netherlands. The entire expense of both these institutes is borne by the State. In addition to these there are a number of other schools of a less complete nature, and also experimental stations.

So much, then, for continental countries. Before passing on to our own country, let me say a word or two with regard to America.

Now, at first sight, it may seem strange to expect to find any developed system of agricultural education in America, and for this reason—namely, that America is a new country; its soil is not yet so impoverished; nature is in a sense more abundant in her gifts; consequently there is less necessity for science in husbandry. Now this is quite true. The soil there is by no means so impoverished, and farming there does not need to be, and, moreover, has not been in the past, conducted in the same "intensive" way as in our own country. Nevertheless, America has recognised the fact that virgin soil will not last for ever, and that, if the necessity for conducting agriculture on the most advanced and scientific lines is not yet clamant, the time will come soon enough, and in the meantime that it is well to be preparing for that day. The States have, accordingly, pursued a most enlightened policy in establishing and fostering agricultural education as much as possible.

The first active steps taken in this direction were taken as far back as 1844. Even previous to this date some of the older colleges possessed chairs of agriculture.

The first agricultural college, however, was founded in 1855 at Cleveland, in Ohio, and within the next three or four years three others were started.

A most important step was taken in 1862, when Congress granted from the public domain 30,000 acres for each senator and representative in Congress. This grant was variously applied. In some cases it was used for founding and equipping an Agricultural Department in existing colleges, while in other cases it was devoted to the institution of new agricultural colleges. The number of institutions receiving this grant I find in 1880 amounted to forty-six, some thirty of which had a total of over 1,000 students, with 100 professors.

It must be added that one of the chief benefits of such endowments has been the very valuable research work carried on at most of these colleges, and the consequent valuable information thus obtained. Their influence has been thus of a very much wider kind than at first sight would appear.

While thus many of the experimental stations are in connection with the agricultural colleges or agricultural departments of the universities, there are others existing in connection with no institution, and for the sole purpose of research and analysis—exercising a "control" function similar to the German ones. To the veteran agricultural chemist, Professor S. W. Johnson, is due to a large extent the honour of being instrumental in establishing the first of these stations—namely, that of Connecticut. This was started by a Government grant of $2,800. It has steadily increased, and in 1884 it was in receipt of $8,000 annually, with property to the value of $25,000, including ample laboratory accommodation, glass-house, &c., and some six acres of ground. There are a number of others, equally efficient, which my time will not permit me to mention.

A reference must be made to the excellent services performed by the American Agricultural Department, which is, perhaps, after all, the most effective public educator. It publishes elaborate annual reports, and disseminates information throughout the country on agricultural subjects.

Turning now to Great Britain and Ireland, let me remark that here, as in other things, there exists a considerable difference between the two countries. I shall begin with Ireland, because in this matter it is, I consider, very much in advance of Great Britain.

Ireland may be said at the present time to possess a very fair system of agricultural education of the most elementary kind. The movement began, as far back as 1831, with the institution of a central school at Glasnevin, near Dublin. Attached to this school was a model farm for the purpose of combining practical instruction with theoretical.

The aim of Government in founding this college was to provide for the training of teachers in agricultural science, who should teach the subject in the national schools throughout the country. At present there are a large number of such national schools where agricultural science is taught, and in addition to them there are also a number of what are called "model agricultural schools" of the type of the Glasnevin school. This stands at the head of these along with the Munster school at Cork.

According to the prospectus of the former of these two institutions, its object is to supply instruction (1) in the science and practice of agriculture to the sons of farmers, to national teachers, and others; (2) in the most improved systems of dairying to young women. The theoretical instruction consists of a series of lectures on such subjects as natural history and botany, chemistry and geology, diseases of farm animals, and theory and practice of agriculture. The lecturer on botany is the professor of that subject in the Dublin University; while the distinguished agricultural chemist, Sir Charles Cameron, lectures on chemistry. The Munster school, near Cork, has also lectures on agricultural chemistry and veterinary science.

Although what is being done in Ireland by Government for agricultural education is, compared with that in other countries, very small, it is very much more than is done for Britain. Nearly everything hitherto effected in this department has been due to private enterprise. Until last year the little which Government had done, in addition to the South Kensington scheme of payment by results, "might be summed up"—as the late Mr. Jenkins pathetically put it—in two lines, viz. :—

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(2) And the grant of £150 per annum towards the endowment of the Chair of Agriculture at Edinburgh University.

With regard to the work of the South Kensington department, I may explain that the "principles of agriculture" is one of the subjects for which, under the Science and Art scheme, properly qualified teachers throughout the country may earn grants. This is being more and more taken advantage of, and it cannot be denied that it has been the means of doing excellent work in the past. While, however, it may serve as an aid to agricultural education, it can scarcely be expected to take its place.

The foundation of the chair of agriculture at the Normal School of Science was distinctly a most important step. By special arrangement teachers may now attend a special course in summer, the department paying their expenses. These teachers come from various parts of the country, their object being to introduce agricultural science as a subject into the schools from which they come.

A scheme similar to this was inaugurated last year at the Edinburgh University, Government granting for the scheme a sum of £300 out of the £5,000 grant. I may be permitted to remark, in passing, that a similar scheme is also being carried out this year in connection with the Glasgow and West of Scotland Technical College, and some forty-two teachers are travelling in from various parts of the country to attend these lectures. Government gives a sum of £250 towards defraying the expenses of this scheme, as well as in recognition of the work being carried on there in promoting agricultural education generally.

The grant of £5,000 has undoubtedly stimulated the movement very considerably, and small grants have been made to various institutions where the subject was already taught, as well as for the promotion of dairy schools.

This is practically all that our Government has done, and it must be confessed that, when it is compared with what is being done by the governments of the respective countries I have just mentioned, the comparison is not in our favour.

Fortunately, private enterprise has done much in this country to make up for the apathetic attitude of our Government; and while it is not my intention in this paper to deal with this side of the question, it would be an unpardonable omission in a paper of this kind not to mention at least those institutions which have nobly been striving to foster this cause. There are in England at present two admirably-equipped agricultural colleges, Cirencester and Downton, where a complete agricultural education may be had.

The first of these, Cirencester, dates back as far as 1845. I cannot take time to describe the history of the movement which ended in its foundation, or to detail the difficulties it experienced in the early days of its existence. It is sufficient for my purpose to say that it is at present in a prosperous condition, and affords for the students of the richer class an admirable opportunity for thoroughly equipping themselves for agricultural pursuits. The other college of this kind is that of Downton, which is also well equipped for providing a first-class agricultural education. Both of these, however, from their very nature, appeal only to a very limited class; and, from the necessarily high fees which, as private institutions, they are compelled to charge, are only available for those possessed of considerable means. In addition to those two colleges there is another at Aspatria, Newcastle, and there is a lectureship at Aberdeen University. In addition to the university chair at Edinburgh, there are two lectureships, one at the Heriot-Watt College, and one in the College of Technology. Of the other chairs or lectureships at present existing in this country, the following are the most important:—the Sibthorpian Professorship of Rural Economy at Oxford, and a lectureship on Dairying; lectureships in King's College and in City of London College. I should also mention that an excellent scheme of Agricultural Education is at present being developed in North Wales in connection with the University College of Bangor.

It would not be fair to omit mentioning the excellent work which has been accomplished in fostering the higher interests of agriculture, both educational and otherwise, by the two national agricultural societies—the Royal, of England, and our own Highland and Agricultural Society of Scotland—by (1) granting diplomas and bursaries to successful competitors; (2) by the keeping up of experimental stations, and by the publication from time to time of the Journal of the Transactions of the societies, which often contain papers of the very highest value.

And lastly, and certainly not least, I would refer to the enormous stimulus which higher agriculture has received in this country from the brilliant and now world-famed Rothamsted experiments. Far behind as a country we undoubtedly are, but from the scientific point of view the Rothamsted experiments go far to make good this deficiency; for the amount and value of the work which has been there carried out is unrivalled by any agricultural experimental station in the world. For this, however, no thanks are due to Government, for the station has been started by, and supported entirely at the expense of, Sir John Lawes, Bart., who has set aside a sum of £100,000 for the purpose of carrying on the station after his death.

I have now given you a brief review of what is at present being done in some of the principal countries of Europe and in America towards fostering agricultural education, as well as a very hurried sketch of what is being done in our own country.

The comparison, as I have already mentioned, is not in our favour. In whatever way we may look at it, we as a country are far behind—lamentably far behind—other countries in this matter. This is all the more to be regretted from the fact that we have enjoyed in the past the reputation of being one of the foremost agricultural countries in the world, and this not without good reason. As far back as 1843 Professor Johnston wrote:—"In foreign countries Scottish agriculture has the reputation of being the best in the empire, and Scottish customs and the agricultural literature of Scotland are familiar to the improving husbandman in almost every part of the world." At that time, from an agricultural educational point of view, Scotland was one of the first countries in the world. After arguing the claims of agricultural education, Professor Johnston says:—"By following out the above course of procedure, Scotland, as she had the first national agricultural society and the first chair of agriculture, would take the lead likewise, and be the first to place a regular and complete course of agricultural instruction within the reach of the owners and holders of the land." This was in 1843; since then the whole of these wide-spread systems which I have just described have been developed, and, in the meantime, what have we been doing? I am sorry to say, practically nothing, as far as extension of agricultural educational facilities go. We who occupied a foremost place some 50 years ago are now no longer in the front, but the rear. This ought not to be so; and I would suggest that the best way of developing agricultural education in this country would be—*First:* by introducing it as an elementary subject into all rural schools. *Second:* by providing facilities for higher agricultural education, by endowing the universities or other higher colleges with faculties or departments of agriculture. In this way the expense would be much less than by the institution of purely agricultural colleges. The science faculty of the university could be utilised for teaching purposes, as is done in the case of the German universities to some extent. *Third:* by the institution of experimental stations and special schools, such as dairy, forestry, etc.

Apart from the utilitarian argument in favour of the introduction of agricultural science into schools, there exists another. There is, I venture to think, no subject better suited to train the mind in habits of observation. It is one of the most suggestive subjects that could be taught, and would go far to bring about what is, I take it, one of the main objects of all education, the habit of thinking for one's self.

According to a writer in the December number of *Blackwood's Magazine*—"The successful farmer of the future must be well grounded in the general and technical knowledge of his business. He must look closely and more carefully into the internal working of his farm than was necessary in former times. He must watch keenly every movement of the foreign producer, study the conditions and prospects of the markets, and be prepared to produce such commodities as are likely to bring him the best return. He must not tie himself to the growing of certain crops and the rearing of certain stock merely because his forefathers did so, or because he himself found them profitable in times gone by. He must cultivate an 'open mind'; be ready and willing to avail himself of any new system or modification of practice calculated to benefit him—being careful, of course, not to attempt upon a large scale practices which are risky or have not been proved by actual test. He must not be above giving his attention to little points of detail or to tiny dribblets of income, for in agriculture the 'day of small things' has assuredly come. Method, precision, industry, forethought, economy, sound and ready judgment, and intelligence—these are the elements of successful business. They are as essential to the farmer of to-day as to the busiest business man in our greatest commercial centre. Conducted by a race of farmers thus qualified, there need be no fear as to the future of British farming."

How, it may be asked, is this to be effected? May I not answer?—"By the introduction of a thorough system of agricultural education."

APPENDIX.

A.—AGRICULTURAL AND FORESTRY INSTITUTES AND SCHOOLS OF GERMANY.

HIGHER AGRICULTURAL AND FORESTRY SCHOOLS.

I. KINGDOM OF PRUSSIA—

1. Königsberg, . .	The Agricultural Institute of University.
2. Breslau, . .	Do. do.
3. Halle, . . .	Do. do.
4. Kiel, . . .	Do. do.
5. Göttingen, . .	Do. do.
6. Berlin, . . .	The Royal Agricultural High School.
7. Poppelsdorf, . .	Do. do.
8. Eberswalde, . .	The Royal Forestry Academy.
9. Münden, . .	Do. do.
10. Berlin, . . .	The Royal Veterinary College.
11. Hanover, . .	Do. do.
12. Göttingen, . .	The Veterinary Institute of the University.

INTERMEDIATE AGRICULTURAL SCHOOLS.

East Prussia, 2; West Prussia, 1; Brandenburg, 1; Pomerania, 2; Posen, 1; Silesia, 2; Schleswig-Holstein, 1; Hanover, 1; Westphalia, 2; Hesse Nassau, 1; Rhine Province, 2.

HIGHER AND INTERMEDIATE AND FORESTRY SCHOOLS.

II. KINGDOM OF BAVARIA.—Munich,* 4; Weihenstephan, 1; Aschaffenburg, 1.

III. KINGDOM OF SAXONY.—Leipzig,† 1; Tharand, 1; Dresden, 1.

IV. KINGDOM OF WÜRTEMBURG.—Hohenheim (the well-known Royal Agricultural Academy) and Stuttgart.

V. HESSE.—Giessen Institute of the University.

VI. MECKLENBURG-SCHWERIN. — Rostock (Agricultural Professor at University).

VII. SAXE-WEIMAR EISENACH.—Jena (Agricultural Institute of the University).

LOWER AND SPECIAL SCHOOLS.

TRAVELLING LECTURERS, &c.

PRUSSIA. — East Prussia, 14; West Prussia, 7; Brandenburg, 12; Pomerania, 3; Posen, 5; Silesia, 12; Saxony, 12; Schleswig-Holstein, 4; Hanover, 15; Westphalia, 30; Hesse-Nassau, 6; Rhine Province, 25 (besides 221 agricultural classes); Hohenzollern, 4.

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* Including the Agricultural Department of the Munich Technical College.

† The Agricultural Institute of the University.

Bavaria.--Upper Bavaria, 6, and 38 agricultural classes; Lower Bavaria, 6, and 14 classes; Palatinate, 3, and 490 improvement classes; Upper Palatinate, 2, and 13 classes; Upper Franconia, 1, and 60 improvement classes; Middle Franconia, 6, and 151 classes; Lower Franconia, 8, and 85 improvement classes; Schwabia, 1, and 100 improvement classes.

Saxony.—14 middle and lower schools.

Würtemburg.—19.

Baden.—20.

Hesse.—7.

Mecklenburg-Schwerin.—2.

Saxe-Weimar Eisenach.—8.

Oldenburg.—2.

Brunswick.—2.

Saxe-Meiningen Hildburghausen.—1.

Waldeck.—Annual grant towards agricultural education.

Saxe-Altenburg.—4.

Reuss.—1.

Anhalt.—3.

Alsace and Lorraine.—6.

B.—THE AGRICULTURAL RESEARCH AND CONTROL STATIONS AND AGRICULTURAL CHEMICAL LABORATORIES OF GERMANY.

I.—Kingdom of Prussia.

	Date of Foundation.	
1. Insterburg,	1858	Manures, Seeds, and Feeding Stuffs.
2. Königsberg,	1875	Do., do.
3. Do.,	1887	Milk Laboratory.
4. Danzig,	1877	Chemical Laboratory and Control Station for Seeds.
5. Dahme,	1857	Physiology of Plants.
6. Berlin,	—	Laboratory of Society of Spirit Manufacturers.
7. Do.,	—	Laboratory of Berlin Brewers.
8. Regenwalde,	1863	Plant Physiology and Soils.
9. Eldena,	1878	Manures, Feeding Stuffs, and Seeds.
10. Posen,	1877	Manures and Seeds.
11. Breslau,	1877	Manures.
12. Do.,	1869	Animal Physiology.
13. Proskau,	1873	Plant Physiology.
14. Do.,	1878	Milk Laboratory.
15. Breslau,	—	Seed Control Station.
16. Halle,	1865	Animal and Plant Physiology (Manures, Feeding Stuffs, and Seeds).
17. Do.,	1863	Experimental Station of the Institute.
18. Arendsee,	1875	Seed Control Station.
19. Kiel,	1871	Agricultural Department (Manures, &c.), and Dairy Laboratory.
20. Do.,	—	Seed Control Station.
21. Kappeln,	1869	Manures, Seeds, and Feeding Stuffs.

I.—KINGDOM OF PRUSSIA (*continued*).

		Date of Foundation.	
22.	Göttingen,	1857	Feeding Experiments.
23.	Do.,	1876	Feeding Stuffs, Manures, and Seeds.
24.	Do.,	1872-5	Laboratory and Experimental Field of the Agricultural Institutè.
25.	Hildesheim,	1870	Manures, Feeding Stuffs, and Seeds.
26.	Bremervörde,	1876	Seeds.
27.	Ebstorf,	1871	Seeds, Feeding Stuffs, and Manures.
28.	Münster,	1871	Do., do.
29.	Marburg,	—	Agricultural Chemical Laboratory.
30.	Wiesbaden,	1881	Agricultural Chemical Laboratory, and Manures, Seeds, &c.
31.	Geisenheim,	1872	Fruit and Vine Industry.
32.	Bonn,	1856	Manures, Seeds, and Feeding Stuffs.
33.	Poppelsdorf,	1856	Plant Physiology.
34.	Kempen,	1883	Manures, Foods, &c.

II.—KINGDOM OF BAVARIA.

1.	Münich,	1857	Animal and Plant Physiology.
2.	Do.,	1875	Agricultural and Physiological Laboratory.
3.	Weihenstephan,	1866	Research and Brewing.
4.	Münich,	1874	Do. do.
5.	Augsburg,	1865	Manures, Seeds, and Feeding Stuffs.
6.	Bayreuth,	1867	Do., do.
7.	Würzburg,	1877	Wine Industry and Food Stuffs.
8.	Speier,	1875	Manures, Feeding Stuffs, and Seeds.
9.	Triesdorf,	1874	Do., do.
10.	Landshut,	1876	Seed Control Station.

III.—KINGDOM OF SAXONY.

1.	Möckern,	1857	Animal Physiology.
2.	Pommritz,	1857	Animal and Plant Physiology.
3.	Dresden,	1862	Chemical and Physiological Laboratories.
4.	Tharand,	1869	Plant Physiology and Microscopic Work.
5.	Döbeln,	1872	Manures, Soils, and Plants.

IV.—KINGDOM OF WÜRTEMBERG.

1.	Hohenheim,	1865	Manures and Botanical Work.
2.	Do.,	1877	Seed Testing.

V.—GRAND DUCHY OF BADEN.

Carlsruhe,	1859	Wine and Tobacco.
Do.,	1872	Plant Physiology and Seeds.

VI.—GRAND DUCHY OF HESSE.

Darmstadt,	1871	Manures, Seeds, and Soils.

VII.—GRAND DUCHY OF OLDENBURG.

Oldenburg,	1876	Manures, Seeds, and Soils.

VIII.—Duchy of Brunswick.

	Date of Foundation.	
Brunswick,	1862	Manures, Seeds, and Soils.

IX.—Grand Duchy of Mecklenburg-Schwerin.

Rostock,	1875	Plant Physiology, Manures, and Feeding Stuffs.

X.—Grand Duchy of Saxe-Weimar.

1. Jena,	—	Seeds, Feeding Stuffs, and Manures.
2. Zwätzen,	—	Agricultural Chemical Laboratory.

XI.—Duchy of Saxe-Meiningen-Hildburgshausen.

Eisfeld,	1872	Manures, &c.

XII.—Duchy of Anhalt.

1. Coethen,	1864	Beetroot Growing, Manures, &c.
2. Bernburg,	1882	Do., do.

XIII.—Alsace and Lorraine.

Rusach,	1874	Plant Physiology.

XIV.—Bremen.

Bremen,	1877	Peat Bog and Meadow Cultivation.

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Apart from the utilitarian argument in favour of the introduction of agricultural science into schools, there exists another. There is, I venture to think, no subject better suited to train the mind in habits of observation. It is one of the most suggestive subjects that could be taught, and would go far to bring about what is, I take it, one of the main objects of all education, the habit of thinking for one's self.

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How, it may be asked, is this to be effected? May I not answer?—"By the introduction of a thorough system of agricultural education."

APPENDIX.

A.—AGRICULTURAL AND FORESTRY INSTITUTES AND SCHOOLS OF GERMANY.

HIGHER AGRICULTURAL AND FORESTRY SCHOOLS.

I. KINGDOM OF PRUSSIA—

1. Königsberg, . .	The Agricultural Institute of University.
2. Breslau, . .	Do. do.
3. Halle, . . .	Do. do.
4. Kiel, . . .	Do. do.
5. Göttingen, . .	Do. do.
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7. Poppelsdorf, . .	Do. do.
8. Eberswalde, . .	The Royal Forestry Academy.
9. Münden, . .	Do. do.
10. Berlin, . . .	The Royal Veterinary College.
11. Hanover, . .	Do. do.
12. Göttingen, . .	The Veterinary Institute of the University.

INTERMEDIATE AGRICULTURAL SCHOOLS.

East Prussia, 2; West Prussia, 1; Brandenburg, 1; Pomerania, 2; Posen, 1; Silesia, 2; Schleswig-Holstein, 1; Hanover, 1; Westphalia, 2; Hesse Nassau, 1; Rhine Province, 2.

HIGHER AND INTERMEDIATE AND FORESTRY SCHOOLS.

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LOWER AND SPECIAL SCHOOLS.

TRAVELLING LECTURERS, &c.

PRUSSIA. — East Prussia, 14; West Prussia, 7; Brandenburg, 12; Pomerania, 3; Posen, 5; Silesia, 12; Saxony, 12; Schleswig-Holstein, 4; Hanover, 15; Westphalia, 30; Hesse-Nassau, 6; Rhine Province, 25 (besides 221 agricultural classes); Hohenzollern, 4.

* Including the Agricultural Department of the Munich Technical College.
† The Agricultural Institute of the University.

Bavaria.--Upper Bavaria, 6, and 38 agricultural classes; Lower Bavaria, 6, and 14 classes; Palatinate, 3, and 490 improvement classes; Upper Palatinate, 2, and 13 classes; Upper Franconia, 1, and 60 improvement classes; Middle Franconia, 6, and 151 classes; Lower Franconia, 8, and 85 improvement classes; Schwabia, 1, and 100 improvement classes.

Saxony.—14 middle and lower schools.

Würtemburg.—19.

Baden.—20.

Hesse.—7.

Mecklenburg-Schwerin.—2.

Saxe-Weimar Eisenach.—8.

Oldenburg.—2.

Brunswick.—2.

Saxe-Meiningen Hildburghausen.—1.

Waldeck.—Annual grant towards agricultural education.

Saxe-Altenburg.—4.

Reuss.—1.

Anhalt.—3.

Alsace and Lorraine.—6.

B.—THE AGRICULTURAL RESEARCH AND CONTROL STATIONS AND AGRICULTURAL CHEMICAL LABORATORIES OF GERMANY.

I.—Kingdom of Prussia.

	Date of Foundation.	
1. Insterburg,	1858	Manures, Seeds, and Feeding Stuffs.
2. Königsberg,	1875	Do., do.
3. Do.,	1887	Milk Laboratory.
4. Danzig,	1877	Chemical Laboratory and Control Station for Seeds.
5. Dahme,	1857	Physiology of Plants.
6. Berlin,	—	Laboratory of Society of Spirit Manufacturers.
7. Do.,	—	Laboratory of Berlin Brewers.
8. Regenwalde,	1863	Plant Physiology and Soils.
9. Eldena,	1878	Manures, Feeding Stuffs, and Seeds.
10. Posen,	1877	Manures and Seeds.
11. Breslau,	1877	Manures.
12. Do.,	1869	Animal Physiology.
13. Proskau,	1873	Plant Physiology.
14. Do.,	1878	Milk Laboratory.
15. Breslau,	—	Seed Control Station.
16. Halle,	1865	Animal and Plant Physiology (Manures, Feeding Stuffs, and Seeds).
17. Do.,	1863	Experimental Station of the Institute.
18. Arendsee,	1875	Seed Control Station.
19. Kiel,	1871	Agricultural Department (Manures, &c.), and Dairy Laboratory.
20. Do.,	—	Seed Control Station.
21. Kappeln,	1869	Manures, Seeds, and Feeding Stuffs.

I.—KINGDOM OF PRUSSIA (*continued*).

		Date of Foundation.	
22.	Göttingen,	1857	Feeding Experiments.
23.	Do.,	1876	Feeding Stuffs, Manures, and Seeds.
24.	Do.,	1872-5	Laboratory and Experimental Field of the Agricultural Institutè.
25.	Hildesheim,	1870	Manures, Feeding Stuffs, and Seeds.
26.	Bremervörde,	1876	Seeds.
27.	Ebstorf,	1871	Seeds, Feeding Stuffs, and Manures.
28.	Münster,	1871	Do., do.
29.	Marburg,	—	Agricultural Chemical Laboratory.
30.	Wiesbaden,	1881	Agricultural Chemical Laboratory, and Manures, Seeds, &c.
31.	Geisenheim,	1872	Fruit and Vine Industry.
32.	Bonn,	1856	Manures, Seeds, and Feeding Stuffs.
33.	Poppelsdorf,	1856	Plant Physiology.
34.	Kempen,	1883	Manures, Foods, &c.

II.—KINGDOM OF BAVARIA.

1.	Münich,	1857	Animal and Plant Physiology.
2.	Do.,	1875	Agricultural and Physiological Laboratory.
3.	Weihenstephan,	1866	Research and Brewing.
4.	Münich,	1874	Do. do.
5.	Augsburg,	1865	Manures, Seeds, and Feeding Stuffs.
6.	Bayreuth,	1867	Do., do.
7.	Würzburg,	1877	Wine Industry and Food Stuffs.
8.	Speier,	1875	Manures, Feeding Stuffs, and Seeds.
9.	Triesdorf,	1874	Do., do.
10.	Landshut,	1876	Seed Control Station.

III.—KINGDOM OF SAXONY.

1.	Möckern,	1857	Animal Physiology.
2.	Pommritz,	1857	Animal and Plant Physiology.
3.	Dresden,	1862	Chemical and Physiological Laboratories.
4.	Tharand,	1869	Plant Physiology and Microscopic Work.
5.	Döbeln,	1872	Manures, Soils, and Plants.

IV.—KINGDOM OF WÜRTEMBERG.

1.	Hohenheim,	1865	Manures and Botanical Work.
2.	Do.,	1877	Seed Testing.

V.—GRAND DUCHY OF BADEN.

Carlsruhe,	1859	Wine and Tobacco.
Do.,	1872	Plant Physiology and Seeds.

VI.—GRAND DUCHY OF HESSE.

Darmstadt,	1871	Manures, Seeds, and Soils.

VII.—GRAND DUCHY OF OLDENBURG.

Oldenburg,	1876	Manures, Seeds, and Soils.

VIII.—Duchy of Brunswick.

	Date of Foundation.	
Brunswick,	1862	Manures, Seeds, and Soils.

IX.—Grand Duchy of Mecklenburg-Schwerin.

Rostock,	1875	Plaut Physiology, Manures, and Feeding Stuffs.

X.—Grand Duchy of Saxe-Weimar.

1. Jena,	—	Seeds, Feeding Stuffs, and Manures.
2. Zwätzen,	—	Agricultural Chemical Laboratory.

XI.—Duchy of Saxe-Meiningen-Hildburgshausen.

Eisfeld,	1872	Manures, &c.

XII.—Duchy of Anhalt.

1. Coethen,	1864	Beetroot Growing, Manures, &c.
2. Bernburg,	1882	Do., do.

XIII.—Alsace and Lorraine.

Rusach,	1874	Plant Physiology.

XIV.—Bremen.

Bremen,	1877	Peat Bog and Meadow Cultivation.

The Income from all sources, including Subvention from the State and Societies of various kinds, ranges from £25 up to £3,000 per annum—the total amount of the Subvention for all the stations being about £31,000.

XIII. — *Electro-magnetic Method of Measuring the Magnetic Constants of the Earth's Field.* By A. TANAKADATE, B.Sc. (Rigakusi, Japan), Physical Laboratory, University of Glasgow.

[Read before the Society, 20th February, 1889.]

THE earth's magnetic field at any particular point is taken to be a uniform one, although, when the magnetic state of the earth as a whole is considered, this is by no means the case. The methods pursued to study the magnetic condition of the earth have always been, and will be, by the study of the field at particular points considered as uniform. Exceptions to this assumption will take place only at the singular points which are the poles and nodes.

Thus the problem of finding the magnetic state of the earth ultimately resolves into that of the determination of uniform field, that is to say, a field in which the intensity of the force exerted on a magnetic pole will be the same in magnitude and direction throughout the space considered; from which it is evident that the magnetic constants at any particular place must be such as to specify this directed quantity. The most natural way of specifying the field will be to give its intensity and its direction referred to some determinate directions on the earth's surface, or by its components along any three lines which are not in the same plane.

The usual system is not by any of these, owing to the peculiar circumstances involved in the experimental determination. It is defined by one of the components and two directions, which are the Horizontal Component, the Declination, and the Dip. The system that I propose may be said to be that of two components and one direction—these being the Horizontal and Vertical Components and the Declination. Remembering that any of those systems of specification are the definition of the one and same field, we can transform from the one system to the other whenever required, and indeed the question of how we define is of little importance if it were not for the experimental aspect of the problem.

The object of the present paper is to show how, by an electro-magnetic process, the determination of the magnetic constants of the earth can be carried out with certain advantages. Of this process only the declinometer may be said to have been fairly tried; the others were tried only in a rudimentary way, and are more of the nature of a suggestion than of the communication of what has been worked.

DECLINATION.

The determination of magnetic declination may be said to consist of two parts—namely, the determination of the axis of a magnet, and the determination of the astronomical meridian through the point of suspension of the magnet, the angle between the two, when the magnet is freely hung, being the declination required.

The electro-magnetic method is to transfer, so to speak, the determination of the axis of the magnet to that of a certain coil which is not suspended, but is adjustable into proper azimuth. It will be seen presently that by using a proper strength of current the method can be made susceptible of considerable accuracy.

This method was originally communicated to the Science Society of Tokyō (Rigakukyōkwai), and also to the Royal Society of Edinburgh. Since then some improvements have been made in the mirror magnetometer, which are fully described in the report of the late magnetic survey of Japan. It will be sufficient, therefore, for my present purpose to explain its principles of construction and operation, referring for detailed information to the papers alluded to.

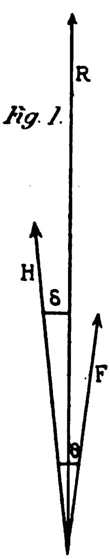
The method depends upon the well-known electro-magnetic action of a closed circuit. If there be any closed electric circuit, say plane for convenience, carrying a current, the earth's magnetic field in its neighbourhood will in general be disturbed to the extent depending upon the strength of the current and the position of the coil. But if the plane of the coil be at right angles to the magnetic meridian the *direction* of the field will remain undisturbed at all points in the plane of the coil. In fact, the plane of the coil belongs to a class of surfaces which I call magnetic funnels, although it may as well be remarked that the part which is inside the coil must be distinguished from the part outside the coil as a separate surface.

In order, then, to find the magnetic meridian, we require a coil of sufficiently good size, and a small mirror magnetometer to judge the direction of the field. This magnetometer is best fixed to a small projecting beam into the centre of the coil, so as to allow the latter to be moved about without disturbing the magnetometer. The magnetometer may be observed either by lamp and scale, or by telescope. Suppose we have such a coil and magnetometer at our command: now make the current; the magnetometer will, in general, be deflected to one side or other; keep the current running, and turn the coil until the magnetometer deflection comes to its original position; break the current, and the magnetometer will now remain still in its position. Reverse the coil, that is to say, turn it through an angle of 180° round an axis normal to the plane of the coil, after the usual manner of collimating telescopes, and repeat the operation; the mean of the two positions will give the magnetic east-west line, and half the difference of the two positions of the coil will give the inclination of the magnetic axis of the coil, and its geometric axis (which might have been referred to its edges). This small angle I call magnetic collimation, by way of analogy.

With regard to the directions of current, there are two—namely, when the field due to the coil has the same sign as that of the earth's field, and when it has the contrary sign. It is best to adjust the coil first into its proper position with the field in the coil, similarly directed as that of the earth's field, and then reverse the current, as will be seen from the following calculation:—

Let H (Fig. 1) be the horizontal component of the earth's field.
- F be the force due to the coil.
- θ the angle between F and H.
- δ the deflection of the magnetometer due to the action of F. Then resolving forces along and perpendicular to the magnetic meridian, we have—

Fig. 1.



$$\tan \delta = \frac{F \operatorname{Sin} \theta}{F \cos \theta \pm H}$$

$$\text{or } \delta \doteqdot \frac{F\theta}{F \pm H} = \frac{\theta}{1 \pm \frac{H}{F}}$$

—from which we see that by making F nearly equal to H, with contrary sign, the deflection of the magnetometer can be made to magnify the deviation of the position of the coil. It is easy to measure what this magnification is by first causing a known deviation, and then measuring the deflection when the current is reversed. When F and H are within $\frac{1}{10}$th or so of each other, with same signs, we may take δ as half the deviation of the coil, and therefore the magnification will be nearly twice the observed ratio of deflections with current direct and reversed. With the special instrument used in the survey I magnified the deviation as much as twenty times, this being the limit which the graduated circle could detect in different adjustments, although there was no difficulty to work with magnifications such as forty or fifty in part of the magnetometer.

It will be seen, however, that when the field due to the coil is brought near to H, the directive force on the small magnetometer will be considerably reduced, and therefore the torque exercised by the suspending fibre becomes no more negligible. The ordinary silk fibre boiled in potash is too rigid to be used. On this account I came to use a suspension with a spider thread, whose torsional rigidity was found to be $\frac{1}{710}$th of that of the silk fibre. Calculation showed me that if I take 5 cm. of the thread the twist of half turn will cause a deflection of about one second of arc. The reason why spider thread has such a small torsional rigidity, while having sufficient tensile strength, seems to me to be in the nature of its structure. The threads consisting of many fibres, like a bundle of wire, which will have very much less torsional rigidity compared with a bar of the same thickness without much loss of tensile strength.

When the suspending thread is exercising a torque, there will be no position of the coil where the make and break of the current will not cause deflection, and consequently there is no danger of getting a wrong result.

In order to apply this method to a travelling instrument the coil is made in two parts, special attention being paid to the form of the coil for securing uniformity in the direction of the field. The pivots, fixed to both sides of the coil, have exactly the same size as those of the telescope belonging to the theodolite.

For the determination of astronomical meridian we have to dismount the coil and magnetometer, and any of the astronomical methods for finding azimuth can be applied.

With regard to the battery, a small Daniell cell consisting of a small bottle with resistances of 1, 2, 4, 8, 16, ohms, was found very convenient.

HORIZONTAL AND VERTICAL COMPONENTS.

The electro-magnetic method of determining the horizontal component of the earth's magnetic field is, as will at once suggest itself, the inverse problem of measuring the strength of current by means of a galvanometer whose geometrical construction is known. Consequently this problem would have been an insoluble one had we not other means of measuring currents than those which depend upon the strength of the earth's field. The precision of this method therefore depends, in the first place, upon the accuracy with which we can measure the strength of currents independent of the earth's field, and, secondly, upon the construction of standard galvanometers.

With regard to the current measurer, Weber's dynamometer or Joule's current-weigher might have answered the purpose, and I had been engaged in studying their working when I left home. But over and above any of such methods hitherto known, the new ampère balances of Sir William Thomson scarcely require my comment, both as to their precision and convenience of working, like many of his other inventions; and it was my seeing his balance which gave me much encouragement to my idea of carrying magnetic survey by means of electro-magnetic method.

I shall therefore leave the consideration of the measurement of current to the new balances, although I do not mean by any means to leave a careful study of corrections to be applied, such as arise from changes of temperature and pressure and variations of gravity, when we intend to use it for an extended survey.*

With regard to standard galvanometers, it would be a mere waste of time had I to detail those already known. Clerk-Maxwell shows how to arrange any number of coils so as to secure the greatest uniformity of field near the point where we intend to place the magnetometer needle. Of these the only ones that have ever been brought into practice in the way of standard instruments are, I believe, the two coils and one coil. The double-coil galvanometer due to Helmholtz, while securing all the requisite uniformity of field, has a great disadvantage in so far as the error

* The variation of gravity between the extremities of the British Island is about ·06 per cent.

in the measurement of the distance between the mean planes of the coils has a greater importance than that in the measurement of the diameters of the coils. Calculation shows that a small error in the measurement of the distance between the mean planes of the coils produces in the final result an error which is 20 per cent. greater than that produced by the error in measuring the radii of the coils. In actual measurement, however, we always take the diameter of the coil which is twice the radius, so that, supposing the error of lineal measurement to be the same in both cases, we can obtain a greater accuracy in the final result by using a single coil of only half the size of either of the double coils. In fact, the objection which applies to Gaguan's arrangement, of which Helmholtz's is an extension, applies equally to the case of double coil, only under a modified form. Mr. Thomas Gray* has shown how, by using a solenoid of moderate length, the errors of lineal measurements can be reduced to a very insignificant amount, the only important term being the determination of the rate of windings of the wire. This method, although useful in its own way, has a disadvantage for the present purpose in so far as the solenoid has a large moment of inertia.

The plan I propose is to make a plain single coil, like the one I have here on the table, and mount it on a theodolite in the way to be described later, and use either the sine or tangent method of observing deflections. The current being put in series with the balance and rheostat, we have H, the horizontal component in terms of known quantities, thus:—

$$H = C \text{ cosec. } \theta / G,$$

$$\text{or } H = C \text{ cot. } \theta / G$$

according as sine or tangent method is used; C being the current, θ the deflection, and G the galvanometer constant.

The objection hitherto raised against the single coil, I believe, was that it did not give sufficient uniformity of field at the centre of the coil, where, unfortunately, we cannot place the two poles of any actual magnet. At present, however, small magnets are made to such a degree of perfection that this source of error can be reduced to a very insignificant amount. If we take a coil,

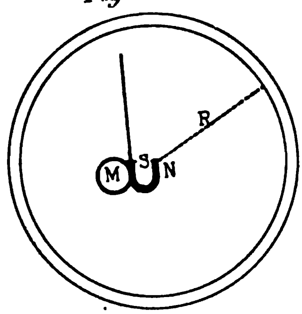
* *Phil. Mag.*, Oct., 1886.

such as I have here, 30 cm. diameter, and the magnet of 5 mm., the amount of correction will be only $\frac{1}{20,000}$th of the value.

When the tangent method of observing galvanometer deflections is used, there is the well-known angle (26°·6) of deflection, at which the correction due to the length of the needle vanishes, the needle being sensibly small compared with the diameter of the coil. But when the sine method is used the correction will always be constant so long as the needle and coil remain the same, and can be calculated when we know approximately the centres of action in the needle.

There is one way, however, of eliminating this correction, or at least reducing it to a very small amount, which is, to hang the needle, not through the centre, as usual, but through one of the poles (or centre of action), and place the free pole at the centre of the coil. We may take with advantage a small horse-shoe magnet, as in the sketch, Fig. 2; the pole which is fixed to the fibre is practically stopped from all degrees of motion except round itself. The magnet might be balanced by the reflecting mirror, as in the figure

Fig. 2.



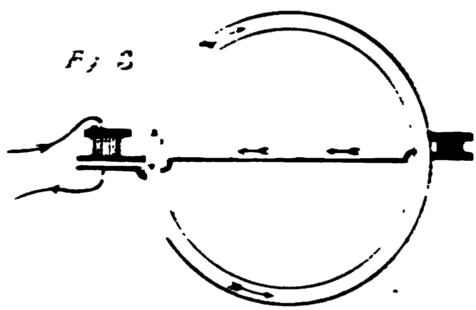
The plan for determining the Vertical Component is to use a balance, consisting of a single coil, and acted upon by the earth's field, instead of being acted upon by a number of fixed coils. The coil is hung by a pair of ligaments of fine copper wire, through one of which the current is made to enter the coil, and leave it through the other. Knowing this current by means of the ampère balance, and the area comprised by all the windings of the coil, we can easily calculate the couple acting on the coil in terms of these, and the intensity of the field at any position of the coil. Thus, when the plane of the coil is vertical, and the axis through the ligament is horizontal, the amount of this couple will be AiV; where A is the sum of areas enclosed by all the windings, i the strength of the current, and V the vertical component. Balance this couple by a known weight w acting at a leverage l, and we have

$$wgl = AiV,$$

g being the force of gravity at the place of observation.

Placing the coil with its plane horizontal with the axis of rotation in magnetic east-west line, and balancing in like manner, we can obtain the horizontal component H instead of V. This method, however, is not desirable to resort to, especially when the value of V is great compared with H (or when the dip is high), on account of the error arising from slight imperfections in adjusting the plane of the coil, as will be seen later. Generally speaking, the method of deflection will be preferable for H.

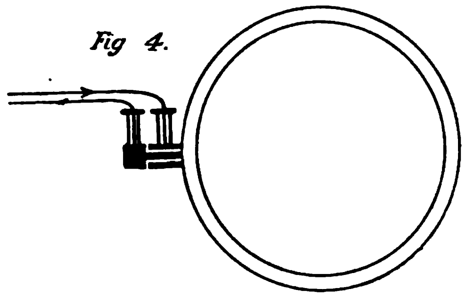
Before we proceed further, the attachment of the ligament seems to require some notice. We must lead the current to and from the coil in such a way that no part of the current which is not included in the calculation of the area will affect the coil in the way of giving a couple about the line through the ligament. The way adopted in the present construction is to lead one end of the wire to the ligament, and to connect the other end to the frame of the coil in the immediate neighbourhood of that ligament. The current, therefore, divides itself on both sides of the circumference, and joins the other ligament, whence it is joined to a straight wire along the axis of rotation as in the subjoined diagram. Fig 3.



If there is any doubt as to equality of current along the two parts of the circumference of the frame, a very simple test can be applied to find this inequality, by observing the potentials along two parts of the circumference, after the fashion of Wheatstone's bridge; and a special diameter may be selected.

An alternative construction will be to lead the terminals from only one side of the coil by concentrically insulated leads, as in Fig. 4.

Fig 4.



The ligament at the other extremity of the diameter is to be entirely insulated from the wire in the coil, or it may be replaced by an agate plane, and a knife-edge, which, if placed toward the centre of the coil, instead of being at the extremity of the diameter of the frame, might prove advantageous in some case for releasing the ligament from bearing the whole weight of the coil.

In order to eliminate the determination of the precise position of the axis of rotation of the coil, in measuring the leverage of the balancing weight, we may take a straight bar symmetrically extending towards both sides of the axis, with a knife-edge at each end; and use each of them in succession with current direct and reversed. This will further diminish the percentage error in measuring the leverage.

The errors that will come into the final value of either H or V will principally arise from two sources. These are:—*First*—The measurement of the dimensions of the coil, the weight and its arm, and the constant of the ampère balance to be used; the errors due to this source will remain the same with any set of instruments so long as the mechanical construction is not altered. *Second*—Those arising from the position of the coil with regard to the earth's field, which will change with every new adjustment of the instrument when it is carried from place to place.

Expressing V in terms of the quantities involved as before—

$$V = lm\,g\,/\,AC,$$

and differentiating we have

$$\frac{dV}{V}=\frac{dl}{l}+\frac{dm}{m}-\frac{dA}{A}-\frac{dC}{C}$$

—whence the percentage error in the value of V, when those of l, m, A, and C are of given magnitudes Δl, Δm, ΔA, ΔC will be

$$\frac{\Delta V}{V}=\pm\sqrt{\left(\frac{\Delta l}{l}\right)^2+\left(\frac{\Delta m}{m}\right)^2+\left(\frac{\Delta A}{A}\right)^2+\left(\frac{\Delta C}{C}\right)^2}$$

In designing any particular instrument we have to make this as small as possible. Evidently the error is diminished by increasing each of the quantities involved. But in practice we reach our limit of current because of the heating effect, and our limit of area on account of the convenience for transportation. These two are to be fixed to suit the convenience, and then l and m are to be settled by the condition

$$lm = \text{const. and}$$

$$d\left\{\left(\frac{\Delta l}{l}\right)^2+\left(\frac{\Delta m}{m}\right)^2\right\}=o$$

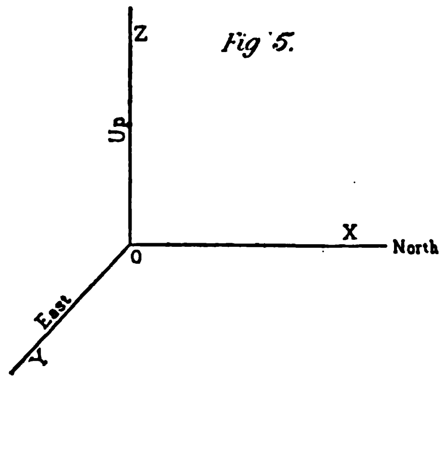
which gives

$$\frac{\Delta l}{l}-\frac{\Delta m}{m}=o$$

—that is to say, we are to make their percentage errors equal.

With regard to the position of the coil, take the axis of co-ordinate along the magnetic N.-S. and E.-W. for x and y, and z upward; then, when the normal of the plane of the coil or its

Fig 5.



magnetic axis makes angles a, b, c, with x, y, z axis, the magnetic moment along the axis will be

$$\mathrm{AC}\cos a,\quad \mathrm{AC}\cos b,\quad \mathrm{AC}\cos c,$$

and therefore the couples about x, y, z axis will be

$$\begin{aligned}&\mathrm{AC}\,(\cos c\ \mathrm{Y}-\cos b\ \mathrm{Z})\\&\mathrm{AC}\,(\cos a\ \mathrm{Z}-\cos c\ \mathrm{X})\\&\mathrm{AC}\,(\cos b\ \mathrm{X}-\cos a\ \mathrm{Y})\end{aligned}$$

respectively, X, Y, Z being the components of the field along the axis. If the axis of rotation (line through the ligaments) make angles $\alpha\ \beta\ \gamma$ with the co-ordinate axis, then the moment of couple round the axis will be

$$\mathrm{AC}\Big\{\cos\alpha\,(\cos c\ \mathrm{Y}-\cos b\ \mathrm{Z})+\cos\beta\,(\cos a\ \mathrm{Z}-\cos c\ \mathrm{X})\\+\cos\gamma\,(\cos b\ \mathrm{X}-\cos a\ \mathrm{Y})\Big\}$$

Which is balanced by the action of weight mg at the arm l. Also $\mathrm{X}=\mathrm{H}$, $\mathrm{Y}=o$, and $\mathrm{Z}=\mathrm{V}$, so that

$$\begin{aligned}&(\cos a\cos\beta-\cos\alpha\cos b)\ \mathrm{V}\\&+(\cos b\cos\gamma-\cos c\cos\beta)\ \mathrm{H}=\frac{lmg}{\mathrm{AC}}\quad\ldots(1)\end{aligned}$$

Differentiating the above expression with respect to a, b, c; and α, β, γ, we have

$$\begin{aligned}&-\ \mathrm{V}\cos\beta\sin a\ d\,a\\&+(\mathrm{V}\cos\alpha-\mathrm{H}\cos\gamma)\sin b\ db\\&+\mathrm{H}\cos\beta\sin c\ d\,c\\&+\ \mathrm{V}\cos b\sin\alpha\ d\,\alpha\\&-(\mathrm{V}\cos a-\mathrm{H}\cos c)\sin\beta\ d\,\beta\\&-\mathrm{H}\cos b\sin\gamma\ d\gamma\qquad\qquad(2)\end{aligned}$$

Hence, when the axis of the coil is along E.-W. line and that of rotation along N.-S., that is

$$a=\pi/2,\quad b=o,\quad c=\pi/2\,;$$

and

$$\alpha=o,\quad \beta=\pi/2,\quad \gamma=\pi/2$$

(1) gives V independent of H, and (2) shows that the errors of adjustment with regard to the position vanish, except the last ($d\gamma$), so far as the first orders of small quantities are concerned. So that the greatest precaution in setting the instrument is to be

given to the level of the axis of rotation, which is the line through the points of contact of the ligaments. When the coil is mounted upon a theodolite this error can be eliminated by making two observations, one with change of azimuth of 180°,

$$\text{making } a=\pi/2 \quad b=\pi/2 \quad c=o$$
$$\alpha=\pi/2 \quad \beta=o \quad \gamma=\pi/2$$

that is to say, the plane of coil horizontal and the axis of rotation at right angles to the magnetic meridian, we get H, independent of V, from (1). But the errors arising from the perpendicularity of the magnetic axis of the coil (da), enter the result in first order of small quantities, as indicated by (2). This is the reason why this method of determining H is to give way before the deflection method, particularly when V is greater than H.

It thus appears that the magnetic constants H, V, and declination can entirely be carried by an electro-magnetic method with certain advantages, especially with regard to the time occupied in carrying the experiment. The time may even be shortened by making the H and V determinations simultaneously—that is to say, while the coil is kept in vertical position by weight, a small magnetometer may be placed in the centre of the coil, and its deflection observed by tangent method; or rotating the coil about the vertical axis (as is possible when it is mounted upon a theodolite), the sine method may be used; the small magnet used as magnetometer having its axis horizontal will give no disturbance to the balanced coil.

In most practical cases, however, the ratio of the couple to be balanced by weight, and the field at the centre of the coil to be compared with H by deflection, will be inconveniently great to make exact measurements; although theoretically there is no difficulty to make this ratio anything we want, for the simple reason that the couple to be balanced increases as the square of the radius of the coil, while the field at the centre diminishes inversely as the radius.

The ratios of H and V in most places on the earth are such as to make this method impracticable unless we have a very good means of measuring small weights. So that for the present we shall be satisfied with separate determinations of H and V with two strengths of currents, although I do not entirely give up the idea of trying the simultaneous method.

It only remains for me now to mention why I came to think of such a plan, notwithstanding the improvements which are added to present methods. The great want in the instruments used in magnetic survey at present seems to me to be the difficulty of ascertaining diurnal variations of the constants, except by using a number of observers at the same time. To give an illustration, the determination of H requires about half-an-hour, even by practised hands. In order to obtain a fair value of dip, 38 angle readings are required, and even after all that we are not sure as to the axis of magnetisation in the needle.

Another point is that the present system of H Declination and Dip fails at high latitudes, where we have to resort to Lloyd's method of vibrating dip needle to get a fair knowledge of the intensity of the field. In the H.-V. Declination system, which has just been discussed, this difficulty will entirely be overcome.

The views thus far advanced are, as stated in the introduction, merely a kind of suggestion; and I do not by any means propose to carry the process out without a thorough trial, which, unfortunately, I have not yet made.

XIV.—*On Present Tendencies in Classical Studies.* By Prof. R. C. Jebb, M.A., LL.D., being his Inaugural Address as President of the Philological Section.

[Read before the Society, 20th February, 1880.]

The institution of a Section of Philology in the Philosophical Society of Glasgow may justly be regarded as an event of some interest, even in the history of a Society so distinguished and so useful as this has been. I am bound to say at the outset that I have no claim to even the least share in the merit of having promoted this addition to the fields of work which the Society comprehends; that credit belongs, I believe I may say, to Dr. Colville, Mr. James Morison, and other gentlemen who have co-operated with them; and when they did me the honour—one which I appreciate highly—of inviting me to become President of the Section, I felt considerable hesitation in occupying a place which ought rather, as it seemed to me, to have been filled by one of them. I am not a comparative philologist; and if Philology, in relation to this Section, was to bear the specific sense which is sometimes attached to it in this country, then I had assuredly no title to become President of it. But I was reassured on this point by learning that Philology, as the subject of this Section, was intended to be taken in that larger and undoubtedly fitter sense of the word which it bears in other countries, and to which the usage of scholars ought certainly to fix it in our own—that is to say, the study of language and of literature without distinction between ancient and modern, and without exclusion of anything which is needed for the full comprehension and illustration of either. By permitting the establishment of this new Section, the Philosophical Society of Glasgow gives a proof that it interprets the word philosophy in its oldest and widest sense—the love of *knowledge.*

The remarks which I have the honour of addressing to you this evening are intended to be in the nature of an inaugural address for the Section; so, in selecting my subject, I was obedient to two conditions, both of them somewhat difficult to fulfil: first, that the subject must have somewhat of a general character; next, that it must belong to that part of the wide domain of Philology with which I was in some degree conversant.

If we wish to comprehend the forces which are at work in the classical studies of the present day, it is well first to glance backward for a moment and to see how those forces have been prepared. Some four centuries have now elapsed since the interest in classical antiquity was revived, after the neglect or oblivion of the middle ages.

The general course of classical scholarship since that time has shown certain successive tendencies, and they are those which might naturally have been expected. The first century or so after the revival—the period from about 1450 to 1550—was one in which men were chiefly occupied with the beauty of classical expression. The form so far excelled anything with which they had been familiar that it fascinated them; their first ambition was to reproduce something of this beauty in their own writing. This is the period of the Latin stylists, occupied with the *imitatio veterum*, and best represented by the name of Erasmus; though he, of course, was much more than a stylist.

Erasmus was 31 years old at the death of Savonarola, the hero of George Eliot's "Romola," a novel which helps one to realise the intellectual and social atmosphere of that time in Italy. Then, when the first novelty of classical style had worn off a little, came the desire to grasp the *matter* contained in the classical books. Between 1550 and 1650 we have Joseph Scaliger, with his great effort, at once erudite and brilliant, to frame a critical chronology of the ancient world; and Casaubon, with his indefatigable labours in the study of ancient manners. Thus, within the first two centuries after the revival of letters, we find curiosity drawn successively towards the two most obvious aspects of the rediscovered treasure—the beauty of its form, and next, the wealth of its contents. But now a third phase sets in, represented by Bentley, in the late 17th and early 18th century. He was struck by the fact that the classical texts, which had hitherto been accepted with comparatively little criticism, have come down to us in a very corrupt state. He was as much interested as Scaliger and Casaubon in the *realien* of classical study; but he felt that, before we could make further progress in a sound way, we must be sure of the ground under our feet—we must purify the texts.

Bentley died in 1742. For about a century after his death we may say, speaking broadly, that no new and distinct tendency manifested itself in classical studies; none, that is to say, which was more than a continuation of lines marked out by such men as Erasmus, Scaliger, Casaubon, and, above all, by Bentley, who is peculiarly remarkable for the fecundity of his work in germs or hints, which successors developed. In his own country his successors followed him mainly in the track of textual criticism; but in Holland and Germany he has always been recognised also as the maker of an epoch in historical and literary criticism (as represented especially by his Letter to Mill, and his "Dissertation on Phalaris"), so that Bunsen could say—"historical philology is the discovery of Bentley—the heritage and glory of German learning."

The new tendency which has come into classical studies during the last forty or fifty years might be described, for the sake of brevity, as the spirit of science. I wish to explain, as clearly as possible, exactly what I mean by this statement.

If we consider the first three centuries after the revival—the time from Erasmus to Bentley—we see that the general characteristic in the history of classical scholarship was the predominance of the individual genius. A man of powerful personality would arise and make an epoch. The work which he did was emphatically his own; he was bound by no rules or methods, except such as he might have framed for his own guidance; if he resorted to conjecture, he employed it with entire freedom, making his own sense of fitness the ultimate test. Bentley is, of course, the strongest example of this, and he is also the most apposite for our purpose, since his influence was so strongly felt by succeeding scholars. Thus, in the preface to his Horace, he says—"I give more things on conjecture than by the help of manuscripts. . . . Shake off the exclusive reverence for scribes. Dare to have a mind of your own." This attitude was natural in pioneers like Bentley and the men before him. It was, indeed, the only possible one at that period. But before the middle of the present century had been reached, several causes had contributed to modify the classical scholar's view of his relation to his materials. First of all, many generations had now been busied with the work of illustrating classical antiquity. A large literature of criticism and comment had been accumulated. In studying this literature an intelligent reader could not fail to be struck with the fact that every critic had done that which was right in his own eyes. Individual insight and taste had had the freest scope, and had accomplished wonders; but was it not time to see whether an agreement was possible on some general principles? To take two provinces of classical learning in which this need had long been apparent—etymologies of a purely conjectural and sometimes absurd nature were often given to Greek or Latin words; and in textual criticism conjectures were often propounded, and even received, without any reference to the manuscripts, but simply because they struck the critic as good in themselves. Another defect in the treatment of classical antiquity had hitherto been the absence of any systematic attempt to bring the evidence of the literature into relation with the evidence of the monuments, —the buildings, statues, stones, vases, coins, inscriptions, and other relics of the civilisation to which the literature belonged.

Under the influence of such perceptions as these, new branches of special knowledge were gradually developed. Within the last half-century a science of language has been created by the application of the comparative method to linguistic study. The old haphazard etymologising has been banished for ever; derivations which satisfied Plato, and which could not have been disproved by Bentley, can now be refuted by every possessor of an elementary text-book. The study of manuscripts, as such, has become the science of palæography; and if any one desires to realise what arduous labour it has enlisted, it is enough to look at the well-known work of Gardthausen, published ten years ago, which is devoted exclusively to Greek palæography. Textual criticism, aided, in some respects, by scientific palæography, and in others by the progress of linguistic research, has lost very much of the vague and arbitrary character which belonged to it in old days.
The degree in which it has now approximated to the condition of
a science may be seen, for example, in the chapter on "M But, it
of Textual Criticism," in Drs. Westcott and Hort's "Int separable
to the New Testament." Again, the systematic stud extent; but
tions has opened up a vast field, which has dema alent intellec-
demands, the best work of many minds; and t ality, regarded
of epigraphy has shed abundant light on every ar, and that the
of antiquarian study. It is enough to allude to rom all the others
—Mommsen's "History of Rome." But a pa sirable. Another
due to the fact that, in the case of classical ire to be thorough
evidence which has now been collected from of scholarship—of

Philology in the large sense—makes them feel that thoroughness is impossible unless they restrict themselves to one plot of ground; when they have chosen it, their interest becomes concentrated on it and on those who are doing the same special work, and they soon cease to care much whether they are understood by others.

We gladly recognise that such specialists are doing invaluable service, in their several lines, to the cause of knowledge; but we may also wish that the desire to be scientific was more uniformly tempered by a regard for the nature of the materials with which all scholarship has to deal. Those materials are the creations of the human intellect, whether as seen in the evolution of language, or of literature, or of art. When principles, determined with a scientific precision, have assured the student of language that a kinship is *possible* between two words, one of the elements in the probability which he may have to consider is the precise *usage* of these words, as attested by literature; and here it is no longer enough to be logically exact; it is necessary to possess also that delicate instinct for expression which is called the literary sense. The textual critic who is seeking to amend a corrupt passage may have full command of everything that palæography can tell him, and of all the particular facts concerning the MSS. of his author; he may also be a perfect grammarian; but what will these things avail him unless he has also an adequate sympathy with his author's mind, and unless his procedure is controlled by the literary taste which such an insight bestows? We remember the legendary emendation in *As You Like It*—whether it is more than legendary I do not know—by which the words—

> "*books* in the running brooks,
> *Sermons* in stones,"

were corrected into

> "*stones* in the running brooks,
> *Sermons* in *books*."

It is no exaggeration to say that emendations like this—yes, and worse—have repeatedly been proposed in the texts of Greek poets by excellent scholars who, on the "scientific" side of their work, leave nothing to be desired. Or turn to the study of history—Mr. Freeman will not permit us to call it "ancient"—the history of Greece or Rome. It frequently happens that our estimate of character or motive, our view of a political situation, or our conception of a social phase, must depend on something beyond the mere power to construe our classical author's words according to the rules of grammar; it must be effected, further, by our perception of the tone which his form of expression conveys. In Archæology, again, take what branch of it we will, the literary evidence is often important in its bearing on the monuments, and often depends on nice points of interpretation. Nor can any aid to the comprehension of Greek art be more valuable than that which is given by a true sympathy with the spirit of Greek literature; for the same mind is in both.

If, then, classical studies are to be cultivated with the best result, it is not enough that the spirit and the ardour of scientific research should animate every department of them; it is also essential that in every department the spirit of science should be associated with the literary and artistic sense; a sense which will not only invest the specialist's own work with a higher value, but will also quicken his appreciation of the place which his special work holds in relation to other provinces of scholarship. There is a passage in Gibbon's memoir of his own life where the historian speaks of his early studies in mathematics. He cannot regret, he says, that he ceased to pursue them before the habit of rigid demonstration had impaired the delicacy of his feeling for the finer shades of moral evidence. Whether such a result was necessary, we need not pause to consider. I refer to his remark because it indicates in that great scholar a consciousness that the scientific habit of mind is not, taken by itself, an adequate equipment for dealing with such problems as meet the scholar and historian. In our generation, and more especially in this country, that noble old conception of classical studies which is implied in the term "humanities" has rather fallen into the background—partly from the causes which I have indicated, partly also because we have had so many English translations, and because the practice of Greek and Latin composition (especially verse) has not of late years held quite so prominent a place in school studies as it formerly did. Already, however, one may perceive signs of a reaction in this respect—so far, at least, as prose composition is concerned. And I believe that this reaction will be further strengthened as the study of *modern* languages is gradually established among us on a sound and thorough basis. That expectation may seem paradoxical, and yet I think it is reasonable. For, when people have fully realised that intellectual grasp of a modern language can be more surely tested by the power of composing in it than by the power of using it colloquially, then they will be less disposed to disparage the value of the same test in Greek and Latin. Then, too, perhaps we shall no longer hear that Nature cries aloud to us to teach the classical languages chiefly by an oral use of Dr. Ollendorff's method. There is indeed one essential difference, as regards composition, between modern languages and the classics, which should be well noted here. It depends on the difference between *idiomatic* writing, and writing which is merely correct in point of grammar. In a modern language, when the learner knows only that he is grammatical, but doubts whether he is idiomatic, he can easily decide the point by an appeal to living authority. But in Greek and Latin, the only gauge of idiomatic truth is that which is furnished by the literature; and while it is comparatively easy to ascertain the rules of grammar, it requires very careful study—study which tasks not only intellect, but feeling and taste—to seize that subtle reflection of a living personality which in language appears as idiom, and which can still be apprehended, though sometimes but dimly, and with an inevitable element of uncertainty, in the literary records of the ancient world.

In conclusion, I would venture to say that I believe the time to be auspicious for the establishment of this new Section in the Philosophical Society of Glasgow. There are abundant proofs in this great city, as elsewhere, that the studies which this Section embraces were never being pursued with more earnestness, or with more varied energy, or with better hope, than now.

XV.—*Land Ownership in Scotland*. By ROBERT T. YOUNGER, M.A., LL.B., Advocate.

[Read before the Economic Science Section, 10th December, 1888.]

I FEEL that if I do not owe you an apology for addressing you to-night—of which I am not at all certain—I at all events owe you an explanation. I am not a political economist, and therefore cannot claim to instruct you in your special study; but, as the laws which relate to the ownership of the land form one of the most important of the subjects to which you are in the habit of directing your attention with a view to reforming them, I have humbly thought that such brief account of them as I may be able to give may not be without interest to you.

The first step in all progressive thought is a knowledge of the problem with which you have to deal, and—while I cannot pretend to assist you to the solution of that problem—I shall, as far as I am able, endeavour to lay before you the facts with which you have to deal; concerning myself with the past and the present, but refraining from any attempt to lift the veil of the future.

Those who have been born in an age in which a vast number of ideas—religious, ethical, political, and legal—become, almost at once, part of their daily life and thought, nay, almost part of themselves, are apt to think these ideas to be fixed and immutable as the laws of nature. It requires but little research and reflection, however, to show that these mark but a stage in the development of the thought of the race. It is but a commonplace now to say that our religious ideas owe their origin chiefly to the genius of the Hebrews, our artistic ideas to the genius of the Greeks, our legal ideas to the genius of the Romans. To trace the rise and progress of such ideas to the stage which they have now reached is the familiar business of historians and philosophers.

The existence of a law of progress and development is perhaps more apt to be ignored by the ordinary mind in matters legal than in any other; but it is all-important to keep it before us in this as in other matters. By looking at our laws in their origin and history we shall be the better able to understand their present nature and significance, and to mark the direction in which their reform should proceed if the march of progress is to be maintained.

The land laws of Scotland show the influence of two very distinct sets of ideas, those of the feudal law, and those of the Roman law. The feudal law first held sway, but the Roman law, which had slumbered for 500 years, revived during the eleventh century, and its influence, in conjunction with the feudal system and the ideas of modern thought, has made the laws of land ownership in Scotland what they now are.

The feudal system had its origin among the Franks, Lombards, Burgundians, Saxons, and others, who overran the Roman Empire in the sixth century, or earlier. It attained its maturity four or five centuries later. These northern conquerors, the better to establish the security of their conquests, granted what were called benefices to their followers, under a mutual contract of support and fidelity. These benefices were originally granted for life only, but they gradually became hereditary. Hereditary benefices, which were uncommon under Charlemagne, became the rule under Louis the Debonair and Charles the Bold. Once the hereditary principle was established it became the interest of those great lords who held of the king to give out their lands on the same system, thereby prodigiously strengthening their power. After the removal of the strong hand of Charlemagne, the powers of these great proprietors became enormous, and in the lawless condition which ensued in Europe, it became the interest and the custom of the smaller proprietors who held their land allodially, that is to say, under no superior, to attach themselves to some great lord as the only shield against the rapacity of others. By the operation of such influences, practically the whole of the land in France, Italy, and Germany had by the tenth century come to be held by a system of feudal tenure, the mutual relations of lord and vassal supplying the place of regular government. It was thus not merely a system of land tenure, as we now understand these words, but a system of government which, in the words of Hallam, "has determined the political character of every European monarchy where it has prevailed." "The essential principle of a fief," says the same author, "was a mutual contract of support and fidelity. Whatever obligations it laid upon the vassal of service to his lord, corresponding duties of protection were imposed by it on the lord towards his vassal. If these were transgressed on either side the one forfeited his land, the other his seigniory or rights over it. Nor were motives of interest left alone to operate in securing the feudal connection. The associations founded upon ancient custom and friendly attachment, the impulses of gratitude and honour, the dread of infamy, the sanctions of religion, were all employed to strengthen these ties, and to render them equally powerful with the relations of nature, and far more so than those of political society." When a fief was conferred upon a vassal he performed homage with head uncovered, belt ungirt, and sword and spurs removed, by placing his hands between those of his lord and promising to become his man from thenceforward. Besides performing homage, he also swore an oath of fealty to his lord. Henceforward he was bound to attend his lord in war, and perform other services according to custom, which it would be tedious here to enumerate.

He was also bound to furnish to his superior certain aids—such as an aid for the lord's expedition to the Holy Land, for marrying his sister or eldest son. The superior had the wardship of his vassal during minority, having at once the care of his person and the profits of his estate. He had the right of tendering a husband to his female ward, while under age, whom she could not reject without forfeiting the value of the marriage. And the personal character of the relation is significantly shown by the fact that every vassal who took a fief by descent had to pay a sum to the superior, called a relief; and every person who took it by way of alienation had to pay a fine or composition.

The privileges of the great feudal superiors may be illustrated by those of the peers and barons of France. These were the right of coining money, the right of waging private war, the exemption from all public tributes except the feudal aids, the freedom from legislative control, and the exclusive exercise of original judicature within their dominions.

Such were among the essential characteristics of the system, which, probably introduced into Scotland from England some time after the Norman Conquest, became then and has ever since remained the established system of land tenure. The confusion through which this country passed in its early wars with England, and the consequent destruction of its oldest records and monuments, has thrown a veil of obscurity over the introduction and early stages of the system in Scotland. There is probably, according to Erskine, no Scottish charter extant dated before the year 1095 or 1096.

Most recent researches seem to show that prior to the twelfth century the institutions of Scotland were Celtic in their nature; but, by whatever means brought about, a total change came over them during that century, and, if we leave out of account some of the remoter Highland tribes who retained their early customs to a later period, the feudal system established itself as the system at once of land tenure and of polity. "The Crown became strictly hereditary," (I quote from Hallam) "the governors of districts took the appellation of earls, and the whole kingdom was subjected to a feudal tenure. The Anglo-Norman laws, tribunals, local and municipal magistracies, were introduced as far as the royal influence could prevail; above all, a surprising number of families—chiefly Norman, but some of Saxon or Flemish descent—settled upon estates granted by the kings of Scotland, and became the founders of its aristocracy."

This system, at the time when first authentic records with regard to it are obtainable—and we need not for our purposes go further back—presents two sides. On the one hand it is the system of land tenure, but on the other it is a great deal more than that. The idea of ownership in land which it presents is not the idea we now have. It involves in it almost everything which is included in modern ideas of government and citizenship. The paramount owner of all land is the king, and his kingship is hardly separated from his right of property. His great vassals are his advisers in legislation and his instruments to administer justice, and their powers in both respects are involved in their rights of property in their territory. Their duty to defend their country by arms, their loyalty to their prince, are contained in the charters by which they hold their lands. In the early feudal charters the service for which the lands are given is the *servitium militare* or, as it is called in Scotland, ward-holding, the service being described as service used and wont or services indefinitely (*ut cum armis et equis ad domini imperium quoties mandaverit paatus sit*), and involved the duty of fidelity, implying (1) a negative duty, that he should not in any way wrong the superior, and (2) a positive duty, to reveal any design against his life and fame. Thus the duties of loyalty and military service were involved in the holding of land.

So were the rights and duties of legislation. The King's Parliament in Scotland was composed at first of the immediate vassals, that is to say, the higher clergy, the barons, freeholders, and (at all events in the time of David II.) the representatives of burghs. These feudal tenants of the Crown came in person to Parliament and formed but one chamber.

As the number of lesser barons and freeholders increased these were allowed to appear in Parliament by representatives, a dispensation which grew into a custom, and led to the Parliament being composed of the greater barons, the representatives of freeholders, and the representatives of burghs (elected not popularly but by the magistrates and council)—the form which it preserved till the Union, and in accordance with which the representation of Scotland practically was regulated till the Reform Act of 1832.

But not only were military and legislative duties involved in the notion of land ownership. It also involved judicial rights and duties. The barons, the lords of regality—great vassals who were yet commoners—and royal burghs enjoyed by virtue of their possessions extensive judicial powers, both civil and criminal. The baron, by virtue of the grant of lands *in liberam baroniam*, had jurisdiction in civil questions of debt and such like within his barony. He had also the power of determining questions between himself and his vassals, such as fixing the price of corn due to him by his vassal, and granting and enforcing decree against his vassal for rents, feu-duties, services, and so on. His criminal jurisdiction reached all crimes except treason, robbery, rape, murder, and fire-raising. In some cases he had the power of inflicting death, expressed in his charter as the privilege of "pit and gallows" (*cum fossa et furca*), in others the right of capital punishment was confined to the crime of theft, expressed in the charter by a clause of "outfang and infang thief," that is to say, "thief whether taken in the act or not."

The lords of regality who were commoners holding their lands *in liberam regalitatem* had even a more extensive jurisdiction. Besides civil matters, they had a chancery jurisdiction over the service of heirs, and their criminal jurisdiction extended to every crime but treason. The royal burghs, which were corporate bodies made up of the inhabitants of a special tract of ground holden of the Sovereign, had a jurisdiction attached to them both civil and criminal, in early times very extensive, and which still survives as to lesser matters.

These rights of jurisdiction connected with the ownership of land were not, at all events when we come to the date at which the history of our law emerges from obscurity, exclusive of, but concomitant with, the separate jurisdiction exercised by the king and his superior and inferior courts.

With the exception of the jurisdiction of royal burghs they have now disappeared. But they survived a long time. They were not abolished till after the rebellion of 1745 by the Act 20 Geo. II., c. 43. In the same year, by the Act 20 Geo. II., c. 50, all military or ward-holdings were also abolished, the holdings of the great crown vassals being converted into holdings for an illusory payment, and those of the vassals of subject superiors into ordinary feu-holdings for money payment.

This may be said to have been the final blow which ended the feudal system as a living body in Scotland. It now survives as a system of tenure only; the notions of property which it involved have passed away. It is no longer bound up with the duties of citizenship, military, legislative, and judicial. New notions of the State and citizenship have grown up, and property in land, like property in other things, has become a matter which, in the main at all events, concerns private right alone. But while this was the end, it was not the beginning of the end. At a very early period in the history of our law we see the notion of private property asserting itself apart from feudal duties while adapting itself to feudal forms. The concerns of agriculture and commerce demanded something better than military holdings. Thus at an early period we find feu-holdings, that is to say, holdings in which a return is stipulated in cattle, grain, money, or services, generally agricultural, at first deemed ignoble, but rapidly spreading as the country becomes more settled. The civil law, which revived all over Europe when law first began to be a systematic study in Scotland, brought with it notions of possession and property as a private matter apart from State polity which were applied by our lawyers to the state of matters which they found existing, with the inevitable result that the feudal system was reduced to a shell, a mere system of conveyancing; and the civilian notions of property developed by modern thought now govern our ideas of property and ownership almost as completely as if Scotland had never been a feudal country. Even in our system of conveyancing, feudal forms which existed in almost all their purity till 1847 have by a series of beneficial enactments since that time been so shortened as to be hardly recognisable. All the weary steps in the old procedure are implied, but only what is essential is expressed. But the system has not passed away without leaving its mark, probably both for good and for evil.

The effects upon modern land ownership may be said to be of two kinds—(1) those which arise from its subsistence as the form of tenure, and (2) those which arise from the ideas which it has transmitted from the past regarding the ownership of land, and which show themselves chiefly in the custom of proprietors in dealing with the succession to their property. I propose to glance shortly at both of these.

This brings us to the consideration of the land system as it now is, a system feudal in form, bearing marks, too, of its feudal origin, but having none of its ancient feudal significance.

"The property of land in Scotland" (I quote Professor Bell for brevity) "is held either directly and immediately under the crown as paramount superior of all feudal subjects, or indirectly, either as vassal of some one who holds his land immediately from the Crown, or as sub-vassal in a still more subordinate degree. The two separate estates of superiority and vassalage are held reciprocally either by the sovereign and his immediate vassal, or by the sovereign's immediate vassal and his vassal under him; or successively by vassals still lower, down to the last step of the ownership of land." There is thus a complete chain deriving from the Crown the right of property to every spot of land in Scotland. The right of the Crown, the right of the vassal who holds under it, and, if there be further subordinate rights, the rights of all these down to and including the right of the vassal in actual possession of the land, are all rights of property. It cannot be said that in one there is the right of property, the rights of the others being burdens. Each is to some extent and effect a proprietor. The right which is held by a superior is called the *dominium directum*, the right of the vassal in actual possession the *dominium utile*. The *dominium directum* or superiority in the Crown as over-lord, or in any intermediate superior between the Crown and the vassal who has the *dominium utile*, is not a right of use of the lands, but only a right to the civil fruits of feu-duty, &c., and to what are called the casualties of superiority, payments due at special periods by the vassal to his superior; the *dominium utile* or estate of the vassal acquired by the charter of the superior involves the right of property and inclusive use of the lands, and also of the pendicles, parts, and pertinents, as they are called, of the lands; whether above the surface, as houses, woods, and enclosures, or below it, as coal, limestone, and other minerals, unless these be expressly reserved with all the legal privileges belonging to the lands.

The superior's right in the lands being one of property he has not only a personal action for his feu-duty, but a hypothec for the last or current feu-duty preferable to that of the landlord where it still exists, and an action of poinding of the ground by which he may attach and secure not only the effects brought upon the land by the vassal, but also those brought on the land by tenants to the extent of their year's duty. He has also another remedy called "Tinsel of the feu" or irritancy *ob non solutum canonem*, by which, on the vassal failing to pay the feu-duty for two full years, the superior may raise an action of declarator to have it declared that the vassal has forfeited his feu, and on this being declared the lands revert to the superior, free of all burden.

I have mentioned that the superior, besides his right to feu-duties, has a right to certain casualties. These are payments to which the superior has right at certain periods; for example, a casualty called Relief, payable on the entry of an heir, equal to the amount of a year's feu-duty, a composition of a year's rent payable by a singular successor, that is to say, anyone not an heir entering into the fee; but as the Conveyancing Act of 1874 contains provisions for the abolition of all casualties, except by special stipulation in feus created after its date, and for their gradual extinction by redemption or commutation under existing feu rights, it is needless for me to enlarge upon them here.

There is thus in all land in Scotland a dual or multiple ownership, the rights of the different persons interested being strictly defined and reciprocal.

Further, to the constitution of any right of ownership in land in Scotland writing is indispensable. All grants of land must be in writing, and must be followed by a handing over of the property, which must be evidenced by writing. There is thus, of necessity, written evidence to show who is the proprietor of all land, when he became so, and from what source and on what terms he derives his right. But the existence of evidences, however complete, scattered among hundreds of hands, and exposed to damage by fraud or destruction, could not be regarded as satisfactory, and this led at an early period to the establishment in Scotland of a system of registration of which we are justly proud. By a series of statutes, commencing in 1503, and culminating as regards ordinary land rights in 1617, and as regards burgage tenements in 1681, a complete system of registration was established in Scotland; so that there cannot now, nor could there since that early date, be any right of property in land which cannot be found recorded in the public registers.

The feudal tenure thus gives us interdependent estates in land, evidenced in the fullest manner, superior and vassal each having an interest in the estate and a continuing relation to each other, and the rights of each completely secured.

Now this has one very important result. It enables a proprietor to part with his land in perpetuity for an annual payment, which is completely secured to himself and his successors for ever, a transaction differing at once from lease and from perpetual rent-charge as it is understood in England, or contract of ground annual as it is understood in Scotland. This power has been in the most notable manner employed in the sale of land in towns for the purpose of building—so much so, indeed, that the term "feuing" has in popular language come to denote that operation.

Its advantages in this respect are these:—(1) There is created in the person who takes the property for building a complete right of property for ever. (2) He does not require to pay a large sum down, but is bound only to a small annual payment, which the rent of the buildings he erects will easily cover. (3) The seller also remains proprietor as superior, and as such has the completest security for the annual payment of his feu-duty, having not only a personal action against the vassal for the time being vested with the property, but also the real rights as proprietor of hypothec, poinding of the ground, and tinsel of the feu before mentioned. (4) The superior may impose conditions in his grant as to the mode of building, and so on, with the view of securing uniformity of plan over a large estate, and thus securing the amenity of all the feuars; and these conditions, as he still remains proprietor and in a personal relation of contract with all his feuars, he has an interest and a legal right to enforce.

Where property is for the same purposes disposed by long lease, as is common in England, the purposes of uniformity, amenity, and so on, may no doubt be carried out; but there is absent the right of property in the leaseholder, with the result that after a term of years the property enhanced in value by the labours of the leaseholder, or by the accumulated labours of all the leaseholders in a large property, falls again into the hands of the proprietor who during that period has discharged no duty towards the property except the simple one of drawing the rents.

Where, on the other hand, the property is disposed of outright for a sum, or by contract of ground-annual, the seller is at once divested and loses all interest in the property. Uniformity of plan, amenity, and such like, cease to be any concern of his. His personal action for his ground-annual is against the man with whom he contracts and his representatives, and against them alone. The ground-annual remains, no doubt, a real burden enforceable against the lands into whatever hands they may come, but between the creditor in the ground-annual and subsequent proprietors there is no relation of contract whatever.

Neither by lease nor by contract of ground-annual can there be effected that conservation of the interests at once of the original proprietor, and the man who takes the land for building, and of the amenity of the neighbourhood which is secured by the system of feuing. It is a curious circumstance that a system devised by the semi-barbarous tribes which overran the Roman Empire for the securing of their conquests in the sixth century should in the nineteenth be found eminently suitable for the building of peaceful commercial cities.

Besides the effect which the feudal system has had upon the ownership of land by its subsistence as the mode of tenure, it has had important effects from the ideas which it has transmitted from the past. The feudal idea of property, as we have seen, involved a great deal more than that idea now involves, embracing as it did nearly all that is now included in modern ideas of government and citizenship. The ownership of land carried with it duties and privileges of the highest kind, connected with the defence, legislation, and administration of the State. The power and importance of the individual in the community practically depended upon it. One by one the privileges connected with property in land have disappeared. But the disappearance has been slow, and, indeed, so far as local administration is concerned, it is not yet complete. It is therefore not surprising that there attaches still to property in land an importance altogether unconnected with its commercial value. When privilege and power disappear, social position, as a monument which chronicles the glories that have gone, is built upon their grave. The power of an aristocracy may be swept away at a blow; its social importance will only yield to time. Property in land may cease to carry with it any power or privilege whatsoever; the land-owner does not *ipso facto* cease to be a person of importance in the social world. Indeed, the representative of ancestors who have been a power in the State is perhaps more apt than they to exalt himself on that account. Those who can say "we have been" often rank themselves higher than those who *are*, and their claim is admitted. There is no motto which appeals more strongly to social respect than that of *fuimus*. Such considerations as these have influenced and still influence proprietors in the management and disposal of their property. They show themselves in the proprietors' lifetime in the preference which they display for burdening their lands rather than selling them, and at their death in the mode in which the succession is regulated. In the succession to land in Scotland the law of primogeniture prevails, the property descending to males in their order, and, failing them, to females jointly. With further details of the legal rules in different cases I need not trouble you here. What is more important than the law regulating intestate succession is the almost universal custom which has prevailed among owners of land of voluntarily regulating the succession to their estates in the same manner, and not only so, but of securing the continuance of such an order of succession through generations by means of entails. There is nothing which illustrates better the strength of the desire on the part of the landed class to maintain this order of things, and the gradual spread of more enlightened ideas of public policy, than the history of the law of entail in Scotland.

Previous to the year 1685, when the first Entail Act was passed by the Scottish Parliament, various attempts were made to accomplish this result by the aid of the common law. Clauses were introduced into the title prohibiting the fiar from alienating the fee or changing the prescribed order of succession. It was attempted to enforce this prohibition, first, by the diligence of inhibition, which entitles a creditor to prevent his debtor parting with his estate, and, on this proving ineffectual, by the process of interdiction, a process by which the next-of-kin or the presumptive heir to an estate may obtain from the court a decree restraining a proprietor who is, as it is described, "lavish and prodigal, of weak and facile disposition; easily imposed upon and liable to be concussed to do deeds to his lesion or prejudice," from selling or burdening the estate or contracting debts for which the lands may be adjudged. This also proving ineffectual, Sir Thomas Hope devised two clauses, one to annul the deed attempted to be granted, the other to dissolve and forfeit the right of the person making the attempt. The efficacy of this device was upheld by the court in one case in 1662, to the effect of forfeiting the right of James, Earl of Annandale, to the estate of Stormount; but that decision, since held by a unanimous judgment of the court to be wrong, was so much doubted at the time that the Scottish Parliament, whose opinion as to the benefit of entails not unnaturally coincided with that of the landed class, passed the Act of 1685 sanctioning entails, provided they should contain irritant and resolutive clauses, and to be duly recorded by warrant of the Court of Session in a special register instituted for the purpose, and called the Register of Tailzies. By such a deed the heir in possession was prohibited from transferring or pledging the estate or altering the succession, under the penalty of having his right to the lands declared void and the property passed on to the next heir. As a rule, power was given him by the deed to sell for the purpose of satisfying the entailer's debts, to burden the estate to a certain extent with provisions for widows and children, to feu to a limited extent, and so on. The law of entail remained on this footing till towards the end of the eighteenth century, when a course of legislation directed towards the relaxation of the system began. By a series of enactments beginning with the Act of the tenth year of George III., called the Montgomery Act, and ending with the Entail Act of 1882, the powers of heirs of entail have been vastly extended; and by the Act of 11 and 12 Victoria, called the Rutherford Act, as amended and extended by subsequent Acts down to 1882, the process of disentailing has been rendered easy. The powers conferred upon heirs as to the management and disposal of the estate refer to such matters as the granting of long leases, feuing, making improvements, and charging subsequent heirs with improvement expenditure, excambing, selling of part of the estate to pay the entailer's debts, and such like, and are obtained, as a rule, on application to the court or by the consent of succeeding heirs.

The power to disentail is now on this footing. Disentail is effected by an instrument of disentail executed under the authority of the Court of Session. In some cases no consents are required, in others the consent is required of certain of the subsequent heirs. If any heir refuse his consent, the Court is empowered to ascertain the value in money of his expectancy or interest, and on payment or security for the value to dispense with the consent, and proceed in the disentail as if it had been given. The creditors of an heir

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[illegible]

[illegible]

I have now endeavoured to trace the history of the feudal system in Scotland till it ceased to dominate our ideas of ownership, and to notice the effects it has left, first in the so-called system of tenure, and second in the notions of the importance of property which it has bequeathed to us. It now remains briefly to glance at the modern notion of ownership, and the direction in which it is tending.

The modern legal idea of ownership, as I said at the outset, is founded on the civil law. It is the idea which has been bequeathed by Rome to all the nations of Europe as developed by our own jurisprudence. Accordingly we find it similarly defined in all European systems. In England it is thus defined by Blackstone:—"That sole and despotic dominion which the man claims and exercises over the external things of the world in total exclusion of the right of any other individual in the universe." By the Code Napoleon it is defined as—"The right to enjoy and dispose of things in the most absolute way, provided no use is made of them which is forbidden by law or regulation;" and by the Prussian Landrecht thus:—"The proprietor is one who is entitled himself or through a third party to dispose at his will of the substance of a thing to the exclusion of others." Our own institutional writers thus define it:—Stair calls it "a power of disposal of things in their substance, fruits, or use," and Erskine "the right of using and disposing of a subject as our own except in so far as we are restrained by law or paction." This notion of property as applied to land is thus expanded by Professor Bell:—"The chief attribute of property is the right of deriving from land and its accessories all the uses and services of which they are capable. This right may be considered in relation to others as 'exclusive,' or in relation merely to the subject as 'absolute.' The exclusive right may suffer limitation whenever the public interest requires it; the absolute use also may be restrained, on similar principles, when it tends to the injury or discomfort of the public. Both the exclusive and the absolute use may be extended or restrained by agreements, express or implied, which constitute servitudes; and they are under the burden of public taxes."

The meaning of exclusiveness in property may be thus illustrated:—A proprietor may prevent a neighbour (I quote from Professor Bell) "from projecting a building over his land, or resting it on his wall, or the rain drop from his neighbour's roof from falling on his ground, or trees from overshadowing it, or even a cornice or ornament from extending beyond the line of the boundary, however innocuously." "He may prevent others from coming on his land to take fuel, however necessary to them, and however inexhaustible the supply; or from hunting on his land, or setting foot upon it, or encroaching, however inoffensively." Individual benefit or convenience and the absence of damage have nothing to do with the question. It is upon this right of exclusive possession that the game laws rest. Game is not property by the law of Scotland. The right to kill it is a privilege depending on the exclusive right to the land on which the game is found.

The only limitations of exclusive use which are admitted are those prescribed by public interest or necessity, as, for example, for extinguishing a fire, pursuing a criminal, or destroying a dangerous animal. It is on this principle that the power exercised by the legislature of taking lands for public undertakings is rested.

The absolute use of land is limited in three ways—by neighbourhood, the law of nuisance, and servitude. Neighbourhood prohibits a proprietor from such faulty or careless use of his property as may occasion damage to the property of a neighbour. The law of nuisance prohibits such use as would obstruct the public means of commerce and intercourse on highways or navigable rivers, or such as is noxious, or unsafe, or intolerably offensive to others. Servitudes are burdens on land imposed by agreement, express or implied, in favour of the owners of other tenements, either entitling these other owners to make certain uses of the land, or prohibiting the owner of the land from using his property for certain purposes.

With these exceptions, an owner of land has the absolute and exclusive use, enjoyment, and disposal of it. He may use it as his own, making such contracts by way of lease or otherwise as he thinks fit for the cultivation of it; he may sell it, or he may give it in pledge as security for debt. His property in it is as full and free as, and does not differ in kind from, his property in any moveable subject.

It remains but to say that there are two instances in which there may be property to which there cannot be said to be an owner in this sense. The first is that of estates entailed already noticed, and with reference to which it may be said that they now are practically very nearly in that position. The other is that of estates in which there is one person in the position of life-renter, and another of fiar.

And the mention of these cases brings me to notice the tendency of modern ideas against the existence of any such limited ownerships, and towards demanding that in every estate there must be some person in the position of absolute owner, in so far as regards the public, so that there shall be no property which, owing to legal restrictions, is beyond the range of commerce. This is well instanced by the Bill introduced last Session called the "Limited Owners Bill," the professed object of which, as narrated in a memorandum prefixed to the Bill, was "to get rid of certain evils attending the limited ownership of land in Scotland, of which limited ownership the chief illustrations are afforded by heirs of entail and life-renters," and to attempt "to introduce what are conceived to be certain changes necessary as a preliminary to effecting a wider distribution of the ownership of land in Scotland."

It is somewhat curious to observe that, co-existent with this movement, which tends to assimilate property in land to property in moveables and desiderates the same freedom of use and disposal in one as in the other, there is another proceeding in a totally different direction, of which the Crofters Act in Scotland is an example. The principle of that legislation undoubtedly is the creation of a kind of limited estate in land which shall be *extra commercium*. If the former movement might be described as an instance of the progression from status to contract, the latter may be described as a progression backwards from contract to status. The two movements are plainly antagonistic. Still we find them both proceeding contemporaneously, both advocated by the same set of reformers.

That the former marks the true tendency of modern thought I have little doubt. The latter is a backward step (or, shall we call it a pause?) in the forward movement which the progressive part of the community are bound to make, while their slower brethren in the Highland wilds make up their leeway, lest their antiquated craft be swamped in the unknown sea of modern ideas.

But I am now getting near the veil of the future, and can venture no further. It is your province—not mine—to raise that veil. I trust that by the efforts of your Society, and such societies as yours, there will be found to lie beyond it a future brighter than the past.

XVI.—*A Scheme of Cremation suited to the requirements of Glasgow.* By Mr. JAMES CHALMERS, I.A., Architect.

[Read before the Society, 5th January, 1889.]

(PLATE IV.)

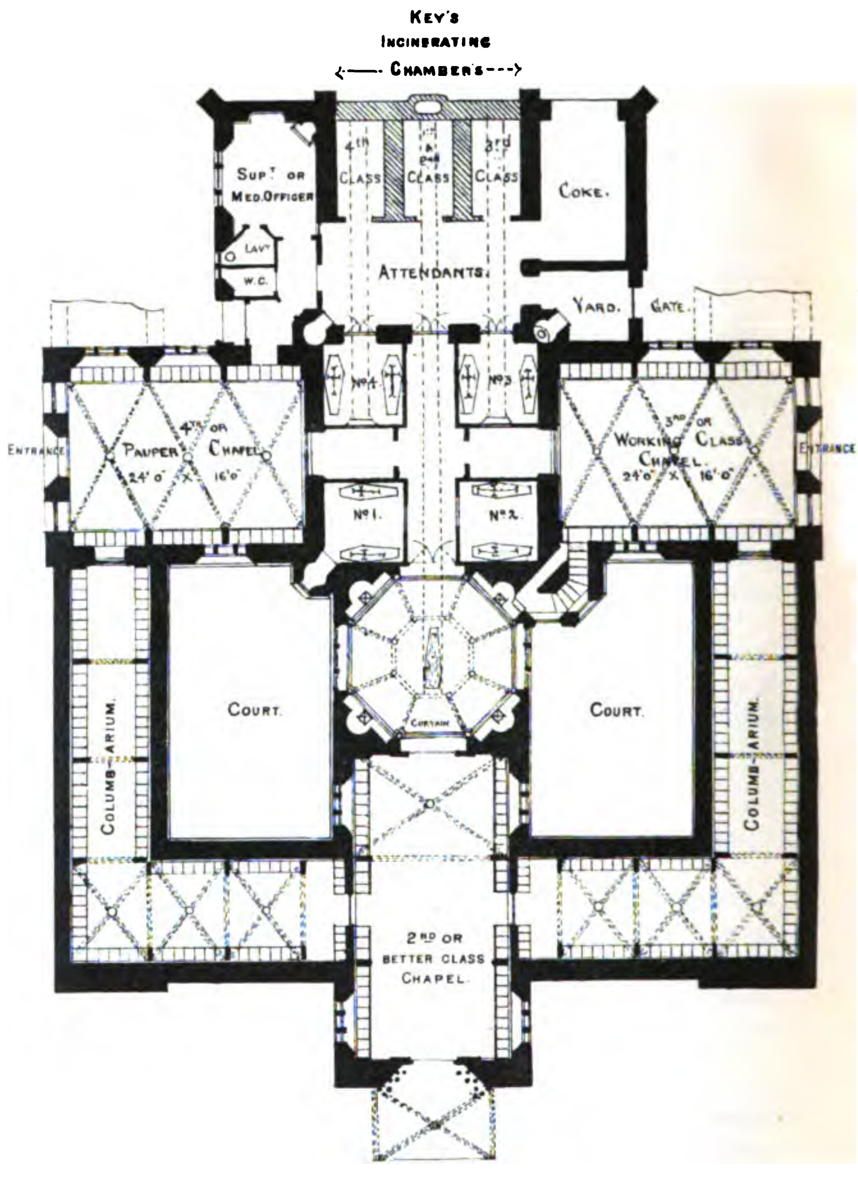
IT has been generally admitted that a careful inquiry into the evils connected with any established custom should precede any legislation or interference of a reforming character. As regards the present system of earth-burial, it will be at once conceded that the preliminary inquiry has already taken place, and that it has been of a most exhaustive character. The report of the Royal Commission on Graveyards, the inquiries by the Cremation Society of England, by Dr. Cameron, M.P., Dr. Ebenezer Duncan, and others, combine with the experiments of the highest sanitary authorities in Europe to prove, 1st, that the poor are buried in an indecent manner; 2nd, that the majority of graveyards are overcrowded; 3rd, that their continuance or increase is injurious to the public health; and 4th, that earth-burial should be discontinued.

This being so, we have reached the second or practical stage—namely, to find a suitable substitute for earth-burial; and cremation, properly carried out, affords the only satisfactory remedy. Now, while I hold that the public are not in a position to give any opinion upon the *practical* aspect of cremation, I note with satisfaction that there is a disposition on their part to remove the evils connected with earth-burial, and in theory at least cremation has received general assent. This seems to the author the most that can be expected at this stage, and it remains for you, or the Scottish Burial Reform and Cremation Society of Glasgow, to present cremation in a form at once scientific, convenient, and, above all things, *religious;* and there is no doubt whatever but that in this, as in other reforms, the people will readily adapt themselves to the new order of things.

Any scheme of cremation suited to the requirements of Glasgow must take into account the possibility of that mode of disposing of the dead becoming general, because, should those adopting it become the majority in place of a minority, as at present, it can only be because of its superiority over earth-burial, and for this reason it may fairly be expected in the end to become general. According to Dr. Russell's figures, the number of deaths which occurred within the city boundaries in 1887 was 12,025; Mr. Mackay's tables give 12,128, and including the suburbs 16,458. The latter is at the rate of 23·22 per 1,000 on a population of 708,792. In 1883, however, with a population of 715,635, the deaths numbered 19,054, being at the rate of 26·63 per 1,000 living. For 1885, again, Dr. Ebenezer Duncan calculates that there were 19,237 interments in Glasgow and the suburbs, and of these 9,027, or about one-half of the total number, were interments in common ground. These figures indicate that we may require to provide crematories at some future time capable of disposing of 20,000 bodies per annum; and, allowing 313 working days, the number per day would be 64. On this basis we must find some data on which to discover the size and form of the crematorium required; and when we remember that the most suitable time for funeral parties is from 1 p.m. to 4 p.m. it will be seen that, with a single chapel, not more than six or eight services could take place in one day; so that at least ten crematoriums would be required to overtake the daily death-rate, unless there were several chapels attached to the one receiving-chamber. It is further evident that, from an economical point of view, the minimum of three chambers should be in constant operation, and to obtain this at least thirty to thirty-two bodies will be required, or a maximum of 10,016 per annum, which is really one-half of the total number of deaths. Taking our data, therefore, from the time occupied by the funeral parties, and keeping in view the great difference in the social position of the respective classes, I suggest four-fold or graded chapels and columbariums.

Referring to Plate IV., it will be observed that there is provided on the high level a chapel for the very rich; the second or better class chapel being on the ground level; the third or working class to the right; and the pauper class to the left of the receiving-room or mortuary. It is proposed that each class should have a separate mortuary in direct communication with Mr. Key's incinerating chambers. As the number from the first and second chapels, however, would not exceed the capacity of one chamber, although separate mortuaries are provided, one chamber would be sufficient. To the left of the chambers, and in connection with the pauper chapel, there is provided a room for the Medical Officer or Superin-

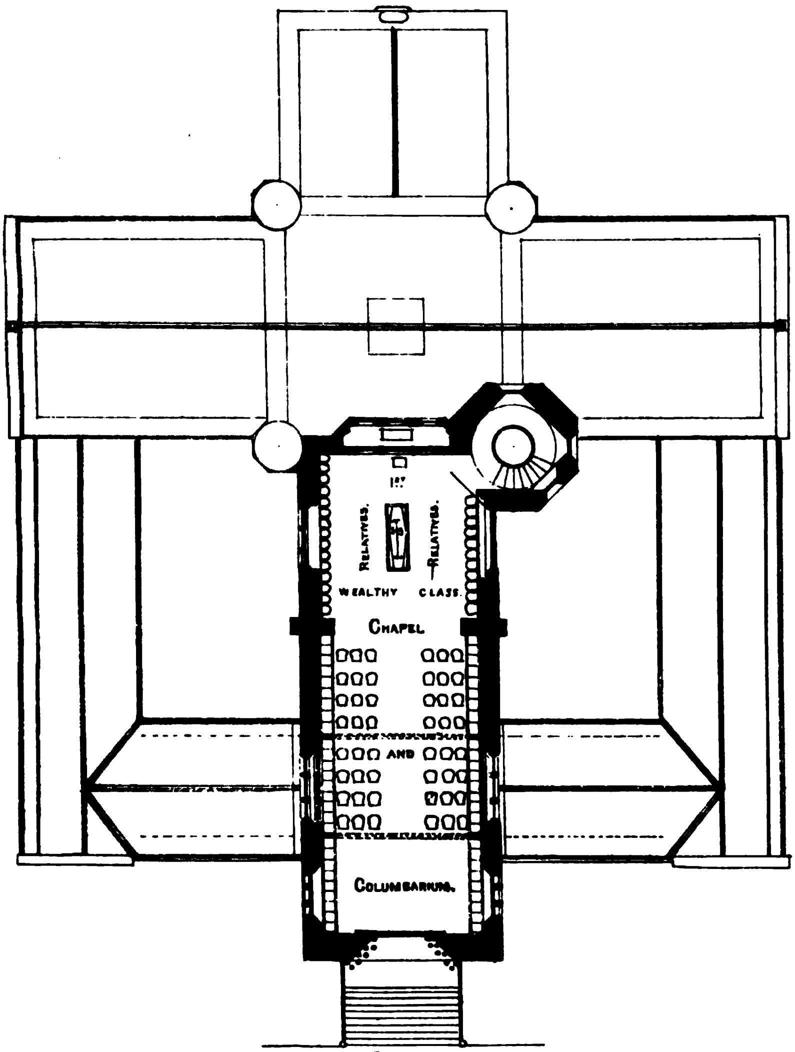
PLAN OF PROPOSED CREMATORIUM.



GROUND PLAN.

SCALE OF 0 5 0 10 20 30 40 50 FEET

Maclure Macdonald & Co. Lith. Glasgow.



PLAN OF
UPPER LEVEL.

tendent, as it is believed that an arrangement of this kind, combined with the adoption of cremation, affords the only effective safeguard against the high percentage of uncertified deaths which, among illegitimate children, is so appalling. I would further suggest that an arrangement should be made for determining whether or not death has actually taken place.

As regards the plan as a whole, it will be observed that it gives opportunity for the most beautiful form of architectural treatment, and the columbariums especially give every scope to those who desire to pay respect for the dead by suitable monuments and urns. In the case of the upper chapels and octagon room containing the elevator, there is every scope for the richest class of material, such as marble, mosaic work, stained glass, and suitable statuary. Possibly the most suitable form would be ecclesiastical architecture of the Norman or early English periods, and the whole arrangement would be suggestive of extreme reverence for the dead. The cost, including the chambers, but exclusive of ground and memorial work, would be about £3,600. If the western brow of the Necropolis or the site behind the Ramshorn Church could be obtained, I think that a crematorium of this character would be one of the places of interest in Glasgow. The cost of cremating 10,000 bodies would be about 2s. each, and a graded rate for the respective chapels and urns would be remunerative to the proprietors, and easily borne by the public. Meantime, however, the erection of an attendant's room and chambers, with one chapel, would be quite sufficient in this early stage of the cremation movement.

In conclusion, the author would suggest that in cases of infectious disease the Philosophical Society should support any movement which would make cremation compulsory; and should it be adopted by private citizens arrangements might be come to with the authorities to cremate the bodies of paupers, in place of burying them in pits.

[NOTE.—A paper on "Key's Crematory Furnace," with an illustration, is given in *Engineering* for 15th March, 1889, p. 252.]

XVII. — *On the Acoustics of Musical Sounds.*

By James Kerr Love, M.D.

[Read before the Society, 1st May, 1889.]

(Plate V.)

I propose to-night to show you a method of testing appreciation of musical intervals, to give you the results of some experiments made with the instrument I use, and to demonstrate some acoustical and musical facts for the demonstration of which I believe this instrument is peculiarly adapted. The understanding of my paper involves a knowledge of elementary principles which most of you possess. I shall in the first place refer to these elementary principles, but shall not dwell on them longer than is quite necessary for the sake of clearness. At the outset I should say that I have approached the subject of the hearing of musical intervals from its physiological side, and that although I have been dragged both into physical and into musical questions, my remarks on these must be considered, without forgetting that I am neither a physicist nor a musician. My instrument is primarily a physiological test. It is secondarily of use for the production of beats, for the exposition of the phenomena of consonance and dissonance, and for the illustration of temperament.

Musical sounds are produced by the periodic vibrations of the sounding body. Such periodic movements give rise to corresponding periodic wave movements in the atmosphere—the usual conducting medium between the sounding body and the ear. Musical sounds differ with regard to their strength, their pitch, and their quality. The strength depends on the extent or amplitude of the vibrations, the pitch on the number of vibrations occurring in any unit of time, and the quality on the wave-form resulting from the vibrations in the sonorous body. It is with the characters of pitch and quality that we have to deal in studying musical intervals and their appreciation. The pitch of the sounds used in music ranges from thirty or forty vibrations per second to something under 5,000. The form of vibration associated with the simplest quality of musical sounds is called a pendular vibration. Its curve is the one which an ordinary pendulum would describe, if its oscillation could be recorded as a curve on a moving surface. This curve is the ordinary curve of sines. The simple pendular vibration corresponds to the tones of tuning forks which have no harmonics. All compound tones—I mean tones with harmonics or upper partials—have more complicated wave-forms, but all these latter can be broken up into as many simple waves as there are partials in the compound. These various simple waves coexist in the air just as several different systems of waves may coexist on the same sheet of water. Before their meeting the components are alike in form; during their coalescence the value of each is represented by some modification in form of the resulting compound. After they have parted the individual simple forms again reappear.

Most musical sounds, then, are not simple. That element which has the lowest vibration number, which is the loudest, and which therefore gives most of its character to the compound, is called the fundamental or prime. The other and higher elements, the upper partials, have vibration-numbers which are 2, 3, 4, 5, 6, or more times greater than the prime.

This theory of the nature of what we regard as separate musical sounds is not a new one. The presence of harmonics has been long recognised, but it is to Helmholtz that we owe the means of isolating and studying individual harmonics. By taking advantage of the phenomena of sympathetic resonance he was able to emphasise the part of the compound corresponding to the proper tones of his resonators. These resonators pick out and strengthen their own tones from the other parts of a compound, just as the voice is seized by the string corresponding to it when a note is sung strongly into a piano.

Convinced, therefore, of the compound nature of the tones usually regarded as simple, let us see what relation the elements have to the prime. The first harmonic or second partial, as it is called, has twice the vibration number of the prime, and is the octave of the prime; the third partial has three times the vibration number and is the twelfth of the prime or fifth of the octave; the fourth partial has four times the vibration number of the prime and forms the double octave; the fifth corresponds to the third above this double octave, and so on. These partial tones are in very simple relationship to the prime, and coincide with some of the chief intervals used in music. We shall hear more of them when studying the intervals themselves.

Besides partials of higher pitch, another set of tones has to be taken into account in connection with musical intervals. These are the differential tones of low pitch having vibration numbers equal to the difference of the two primes or partials which continue to form them. They are of more practical importance than the other kind of combinational tones called summational. The loudest of these combinational tones are the differential tones of the primes, or of one prime and a powerful partial. They can be heard on any good harmonium. I can produce them distinctly on this instrument, as you hear; the deep buzzing sound you hear now when I sound this major third being caused by a differential tone with a vibration frequency of 132, and the fourth tone sounding being the differential one of this 132, and the lowest prime, or G, 396.

Many means have been proposed for determining the rates of vibration or pitch numbers of musical sounds. Some of these are very elaborate, but very accurate, such as the tuning fork tonometer of Schiebler. Others are difficult to manage. The Siren is one of the oldest and simplest, and is perhaps the most instructive. I wish I could have added the most accurate, for the Siren is of great importance in acoustics, chiefly in demonstrating the vibration ratios of musical intervals. This importance makes any improvement welcome which has for its object the obtaining of accurate results with the Siren. This beautiful little instrument, of which I now show you an example, is a frisky creature. It is difficult to tame it down to a steady pace. This difficulty is well illustrated by the complicated mechanisms devised by acousticians to surmount it. Helmholtz has had a small electro-magnetic machine with a constant velocity of rotation constructed, and has found it of great use in driving the Siren. In this case the Siren does not require to be blown, but the air is driven through the openings by means of a small paper turbine. Mr. A. J. Ellis says that the best work done with the Siren has been done by M. Lissajous, with the constant-pressure bellows of M. Cavaillè Coll, called the Soufflerie de Précision. I have not seen this bellows, nor have I been able to find any information regarding it in the library of this Society.

Whatever be the means employed, the end in view is the production of a condition of equilibrium between the pressure of the bellows, on the one hand, and the friction caused by rotation of the spindle, together with the action of gravity, on the other. When the counting apparatus is in action, the friction connected with its working has also to be taken into account. With a bellows of constant pressure there must be a maximum rapidity of the spindle, and therefore a steady note. This note would be attained only when friction made further increase of speed impossible. But then the added friction of the clock-work when counting begins flattens the note and spoils the observation. I have tried to improve the Siren by adding a brake to the spindle, and by using a bellows which is constant in pressure during the lower four-fifths of its rise, but diminishes gradually during the last fifth. This is managed by making the bellows take on small additional weights during its upward progress, except during the last fifth of the journey. Without these weights, or under a constant weight, the pressure increases as the bellows falls; with the auxiliary weights the pressure can be kept constant, for during the fall they leave the bellows in the same ratio as the pressure tends to increase. These auxiliary weights are slung from the roof of the box containing the bellows.

The brake is applied to the spindle, and has for its object the variation of the amount of friction. It consists of a thin silk cord twisted in a figure-of-8 fashion, so as to embrace the spindle by its middle part while the ends of the figure are carried round the uprights of the frame of the Siren. The silk cord is carried round a tiny pulley, and a small scale-pan is attached to its end in which various weights are put. The speed of rotation is therefore under the absolute control of the operator, for the weights on the one hand and the pressure on the other can be kept steady or varied by any given amount. Much practice is required in working the bellows. The weights may be likened to the coarse, and the graduated bellows to the fine, adjustment of a microscope. Dr. W. H. Stone represents the ordinary Siren as rather a defective instrument, and I have some reason to believe him. I am not sure whether he makes the statement on his own authority or on that of some other observer; but he says in his book on Sound that the ordinary Siren of commerce is not practically reliable within ten vibrations. When I began working with the Siren it must have been one of these ordinary commercial examples that fell into my hands. The instrument was made by one of the chief Continental makers, it is true, but had very evident defects in the way that the bearings were managed, and generally was an unreliable and easily-deranged apparatus. In contrast with this I would refer to the example of the Siren which has done service in Sir William Thomson's hands for over forty years. This Siren, which was kindly lent me for the purpose, was my chief guide in giving directions for the making of my own instrument, which, so far as I know, is the first Siren made in Glasgow. It was made by Mr. Macrae, of 10 Richmond Street. (See Plate V., Fig. 2.)

Yesterday afternoon, along with my friend Mr. Younger, I made an attempt to fix, or rather to check, the vibration number of some of these pipes by means of this Siren. The lowest C was found to give a steady note with a weight of 240 grains in the scale-pan, and the counting to give a vibration number of 263·5 or half a vibration flat. The E pipe required 180 grains, and gave 330·6 for 330; the G pipe needed 120 grains, and gave 395·6 for 396. The higher C was weighted with 80 grains, and gave 527·5 for 528; the higher G was heavily enough weighted with the scale-pan itself, and gave 790·5 for 792; and the highest C, which was five vibrations sharp, gave exactly its pitch of 1,061 when the spindle was freed from the weight of the scale-pan. A second observation with this gave 1,059. This last observation was carried over a quarter of a minute only; all the others were for a whole minute. The numbers just given are in no way selected, but were in each case the counting got from a single observation with the pipe tested. These results lead me to hope that this little apparatus which I have added to the Siren will be found of practical value in determining pitch numbers with that instrument.

A convenient and instructive method of treating musical sounds is to range them on a vertical scale, such as is used when measuring heat by the thermometer, the vibration numbers rising as we ascend the scale. Any two notes struck at random would probably give the idea of their having no sort of connection with each other, or the combination might have an actually disagreeable effect. In the latter case we call the phenomenon *dissonance*. But many pairs of the notes when struck together would give an idea of smoothness and harmoniousness which is peculiarly pleasant, and this we recognise as *consonance*. This harmoniousness is greatest when the vibration ratio of the two notes struck is simplest. It is complete when the vibration numbers are the same. It is also perfect when they bear the simple ratio of 2 : 1, or when one is the octave of the other. When the ratio is 3 : 2 we have the perfect consonance of the fifth, when 4 : 3 that of the fourth, 5 : 3 the major sixth, 5 : 4 the major third, and so on; and we may say that the simpler the ratio the more perfect the consonance. And if we study this phenomenon of consonance more closely we shall see that the simple ratios just referred to tell us more. They explain the actual cause of the consonance. They tell us that the corresponding partial tones have the same vibration number. Thus, in the fifth, the third partial of the lower number and the second of the upper have the same vibration number, and are perfectly unisonous. Consonance, then, is a smooth, uninterrupted, continuous flow of two tones. Let us look at the nature of dissonance.

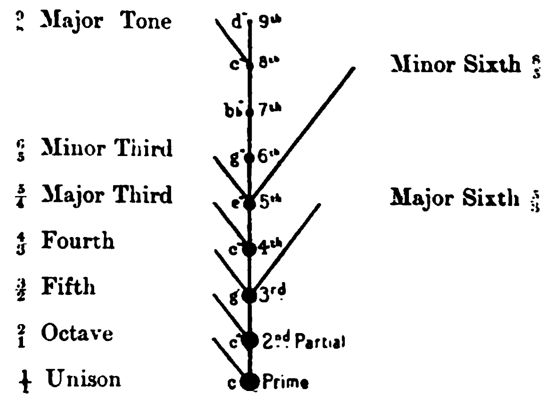
The sound you now hear is from a pipe with a vibration number of 264. By tuning another pipe I make its vibration number exactly the same, and the two pipes may now be sounded together without either disturbing the other. In front of one of these pipes is a graduated scale by which I am guided in lengthening or shortening this pipe till it makes exactly one vibration less or more than the first pipe—263 or 265 per second. When the pipes are now sounded together what is called a beat is heard, which, under the pressure of this large bellows, can be kept up as regularly at 60 in the minute as the pulse at your wrist. On further lengthening the pipe, or on shortening it, I can produce any given number of beats per second, and the number of beats in every case represents the difference of the rates of vibration of the beating sounds. Here is something which has disturbed the smoothness of the consonance. Beats are the essence of dissonance. Up to a certain point you can count them ; now they are so rapid that you would hardly undertake to count them correctly, although they are quite distinguishable as rapid beats. Now—the interval is a semitone—the roughness is extreme, the dissonance is very marked, and the beats are so rapid that unless we had arrived at the dissonance by the preceding gradations we could hardly recognise it as due to beats.

As the distance between the beating tones is further increased the disturbance does not increase. At the major tone it is still great, but not so great as at the semitone, and as we approach the minor third it rapidly diminishes. The minor third, indeed, in the ascending scale is the first of those intervals where the vibration ratio is low, where the coincident upper partials are strong enough to have a marked effect, and consequently where the phenomenon of consonance again reappears. Ascending the scale further we come upon another dissonant area, the dissonance now being caused by the beating, not of the primes, but of the upper partials; then comes a point of agreement at the major third; then a dissonant area followed by the fourth; then another dissonant area followed by the fifth. With the exception of the octave, these last two intervals—the fourth and fifth—are the best consonances we have. They are near the middle of the octave. The disturbance from the primes on the one hand, and the prime and first upper partial on the other, are least. Ascending the scale further, we have the consonances of the major and minor sixth comparable in respect of harmoniousness to the thirds because separated by a distance from the first upper partial similar to that between the thirds and the prime. On approaching the octave the disturbance between this prime and the second partial of the lower note—I mean its first upper partial—causes acute dissonance. On arriving at the octave we have the most perfect consonance.

Perfect consonance, therefore, means all absence of beats. It is the steady, uninterrupted flow of two tones which have no tendency to disturb or cut into each other. Theoretically it is impossible, unless we can be sure that the number of partials is limited, for the eighth and ninth partials in any compound are only a tone apart, the fifteenth and sixteenth only a semitone; and hence the braying, dissonant notes of some brass instruments which have the higher partials strongly developed. Practically it exists when neither the prime, nor any partial, nor any combinational tone is near enough any other element of the compound to form a beating pair with it.

Dissonance is the rough, disturbed, broken sensation of tone caused by rapid beats, rapid enough to produce the disagreeable effect common to interruptions of sensation, but not so rapid as to leave the impression of a continuous flow of sound.

TREE OF CONSONANCE.



For the study of consonance I have constructed a tree of consonance or harmoniousness. (See p. 202.) The discs on the stem are meant to represent the relative strength of the various partials in such qualities of tone as these pipes. After the sixth or seventh their strength is hardly appreciable, and they may be almost disregarded. The intervals derived from the next lowest member in the scale are shown on the left side of the stem, and their position decides their degree of harmoniousness. The degrees of consonance of the unison, octave, fifth, fourth, and major and minor thirds are thus graphically shown. On the other side of the stem are ranged the other consonant intervals, the major and minor sixths, which must find their fellow-partials higher up in the tree than the position of the next higher partial. In a quality of tone such as is here supposed this necessarily weakens the consonance, for the partials lose force as we ascend the scale. The tree is read as follows:—In comparing, for example, the consonance of the fourth and major sixth which spring from the same point on the stem, we call the fourth the better consonance because it finds its fellow-partial at the first higher step on the stem, whereas the sixth must travel to the second for its fellow. Again, when comparing the major third and major sixth, the latter must be called the more harmonious, for although it travels two steps to find its fellow it starts with a stronger partial a step lower in the scale or stem.

The diagram, therefore, shows the intervals to be consonant or harmonious in the following order—the table referring only to intervals within the octave:—

Coincident Partials.	Relative Harm'ness.	Name of Interval.	Distance from C.
1×1	$=$ 1 or 100	1. Unison	C : C
1×2	$= \frac{1}{2}$ or 50	2. Octave	C : C
2×3	$= \frac{1}{6}$ or $16\frac{2}{3}$	3. Fifth	C : G
3×4	$= \frac{1}{12}$ or $8\frac{1}{3}$	4. Fourth	C : F
3×5	$= \frac{1}{15}$ or $6\frac{2}{3}$	5. Major Sixth	C : A
4×5	$= \frac{1}{20}$ or 5	6. Major Third	C : E
5×6	$= \frac{1}{30}$ or $3\frac{1}{3}$	7. Minor Third	C : E♭
5×8	$= \frac{1}{40}$ or $2\frac{1}{2}$	8. Minor Sixth	C : A♭

[NOTE.—The above table is a simpler form of one given in Helmholtz's book—a fact which I only discovered after drawing out this.]

An examination of the coincident and disturbing partials will prove this to be correct.

The Unison.—This is included simply for comparison with the intervals proper. It cannot be actually dissonant unless the very high partials are strongly developed.

The Octave.—The beating of the primes prevents anything like perfect consonance in the lower parts of the scale, but at its upper end the Octave is a perfect consonance, for it simply emphasises certain elements of an already existing combination. It adds nothing new to it. It is easily disturbed from the strength of the partials which then beat.

The Fifth.—In the middle of the octave we have the Fifth depending for its consonance on the coincident second and third partials, both well marked in all good qualities of tone. But it is not to be classed with the octave, for the fifth introduces a new element in its third partial. D, which is only a tone from the C and E, the fourth and fifth partials of C. The beats are too rapid, it is true, to cause disturbance, but the effect is sufficient to separate the fifth from the unison and octave.

The Fourth.—This interval is worse than the fifth, not only because the coincident partials are weaker, but because the beats between the third and second partials of the respective primes are not so rapid as the beating we found in the fifth. Still they are very rapid and produce no great disturbance.

Major Sixth and Major Third.—In the former of these the third and fifth partials are coincident, in the latter the fourth and fifth. Both are therefore good consonances, the Major Sixth having the advantage because of the stronger third partial. This advantage is greater in low positions where the third is sensibly disturbed by the proximity of the primes.

The Minor Third and Minor Sixth.—These intervals are but poorly defined; the coincident partials are of a high order and therefore weak, and the consonance due to the coincidence is much marred in the case of the Minor Third by the proximity of the primes, and in that of the Minor Sixth by a similar proximity of its prime to the second partial of the lower note. These intervals are really on the borders of dissonance, and owe their positions chiefly to their being inversions of the more consonant intervals, the major sixth and third.

From what I have said it will be noticed that, in addition to the positive harmoniousness given to any interval by the coincidence of the partials, there has to be taken into account the disturbance due to the rapid beating of the partials which form the consonances adjacent to that interval. These beats are always rapid, and generally cause no appreciable roughness, but they give special character to the consonance. In the case of the fifth, as we have seen, where the third and second partials are coincident, the partials which coincide for the adjacent interval of the fourth—namely, the fourth of the lower note, or C, and the third of the higher, or D, are only a major tone apart; and although their beats in this high position are very rapid (about 130 per second for the 2-foot C) and cause no appreciable roughness, they give a character to the fifth which is entirely absent from the octave.

Another point to be noticed is that the more acute dissonances are to be found near the best consonances. The semitone gives the maximum of roughness because the strong primes then beat at the rate which in medium positions gives the whole body of sound an intermittent and disagreeable character. And where two partials are strong enough to cause positive harmoniousness by their coincidence, they are strong enough to cause acute dissonance when mistuned. Hence the most acute dissonances are to be found near the octave and fifth.

We have to do with temperament only in so far as its defects are appreciable by the ear. Just intonation or temperament fixes the steps in the scale after the plan we have followed, and has for its object the obtaining of the minimum roughness. But this arrangement is just or natural only with respect to the intervals fixed from a single tonic. If we begin with D instead of C, the interval to F is not a true minor third, nor that to A a true fifth. Both are flat by a fifth of a semitone. The voice can, of course, raise its F and A to suit the D, but keyed instruments, like the piano, cannot. Hence to play correctly we must have two Fs and As. Every change of key would require fresh notes, and indeed for accurate work on the piano we would need from 70 to 100 notes to the octave. Temperament, as applied to keyed instruments, is an attempt to make twelve keys do duty for a much larger number—an attempt to escape the detail which nature asks of us. The unequal temperaments put certain less-used intervals out of tune in order to keep others true. Equal temperament divides the octave into twelve equal semitones. Pythagorean intonation fixed the intervals by a succession of fifths.

Just, equal, and Pythagorean temperaments are compared in the following table:—

Note.	Pythagorean Intonation.		Just Intonation.	Equal Intonation.	
	Vibration No.	Error.	Vibration No.	Error.	Vibration No.
C	264		264		264
D	297		297	− ·7	296·3
E	334·1	+ 4·1	330	+ 2·6	332·6
F	352		352	+ ·4	352·4
G	396		396	− ·5	395·5
A	445·5	+ 5·5	440	+ 4	444
B	501·2	+ 6·2	495	+ 3·4	498·4
C	528		528		528

In the Pythagorean intonation the errors occur in the thirds, sixths, and sevenths. In equal temperament these intervals are affected to a less degree, but the second, fourth, and fifth are slightly out of tune. We shall see whether the ear is cognisant of the errors.

(Illustrations of just and tempered Thirds, Sixths, Fifths, Fourths, and Major Chords were given by the author.)

After this rapid but, I hope, clear statement of the acoustics of musical sounds, let me go on to the subject of the appreciation of musical intervals. The subject has been studied carefully in Germany by Dr. Preyer of Jena, but not much in this country. Dr. Preyer used reeds which have some advantages, I admit, over pipes: reeds retain their pitch and are not nearly so susceptible to changes in temperature. The pitch of a *small* pipe varies on the slightest provocation; these two pipes are so nearly alike in pitch that no beat is heard on sounding them together. I hold one of them in my hand for half a minute, and now they give a harsh dissonance. The pipe will remain sharp for many minutes. These difficulties can be got over only by the most rigid care. In my experiments I never handle a pipe; the movable tops which I shall presently allude to are raised or lowered by this knife or a steel tuner, and if a pipe has to be removed from its place a pair of tongs, the points of which are guarded by rubber tubes, are used instead of the hand. By this means, and by carefully comparing the pipes with a set of standard tuning forks before the beginning of the experiments, a steady pitch is maintained, and the results obtained are reliable. All measurements are, as I shall show, checked by beats.

The experiments with unisons were made with a much smaller instrument than the one I now show you, and the results, along with a figure of the instrument, will be found in the *Glasgow Medical Journal* for August and September, 1888. The instrument consisted of a small bellows in front of which were erected the pipes to be sounded. The bellows was lifted to its highest, and fell through a space of two inches under a weight of three or four pounds, giving a note of nearly a second and a-half in duration. The pitch of the pipes was altered by means of movable stoppers governed by accurate lathe-turned screws. Successive notes were therefore produced under the same conditions, for the bellows fell under a constant pressure through the same distance during the same time. About 200 observers of all ages and at all stages of musical training were tested, and the results, to which I shall presently refer, may be taken as substantially correct; but the instrument was tentative, and was found too small for experiments with intervals; nor could it produce a sustained note. Some observers, too, complained of the dull, woolly character of the tones—a character attaching to the tones of all stopped organ pipes, and due to the absence of some of the partials. I therefore had this larger instrument made, which I have called the "Organ Audiometer." (Plate V., Fig. 1.) It consists of a large bellows, 24 × 30 inches, over which are ranged two octaves of metal organ pipes, the lowest pipe being the 2-foot C with a vibration number of 264. The diatonic scale for these two octaves occupies the front rank, and the semitones occupy the back rank. All the pipes are open. The chromatic pipes are provided with movable brass tops, by which they can be lengthened or shortened at pleasure. In the case of the larger pipes, this is effected by means of the ordinary tuner. The tops of the smaller pipes are raised by means of the screws which I used in the former instrument. These tops have pointers attached to their lower ends which mark off the amount of movement given to the top against a half millimetre scale attached to the front of the pipe. Any tone, therefore, between the notes of the diatonic scale can be produced by the chromatic pipes. The pitch of the diatonic pipes has been fixed by making them difference in method is a very important one, and may account for the apparently contradictory results.

Another point which I have given some attention to is the relative sensitiveness for the major third and sixth. My own case is instructive in this connection. In six tests with the major third of the 2-foot octave (264 : 330) all were correct except one where one and a-half vibrations were not detected, giving an appreciation of 1 : 220. With the major sixth, out of six similar tests, the only error was in not detecting an impurity of two vibrations giving an appreciation of just the same degree. Perhaps the precedence of the third over the sixth in Dr. Preyer's tables is accounted for by the fact that thirds are more used in music than sixths. An amateur violinist, however, gave the preference to the sixth; a vocalist gave it to the third. These two were subjected to a set of parallel tests for all the intervals except the minor sixth. It is curious to note that the only actual mistake made by the violinist was with the fifth, where a flat was put down for one vibration sharp. The fifth, however, had the smallest number of undetected impurities. I do not tabulate these results, for the data are insufficient to warrant the formation of any rigid conclusions; but their general tendency is to arrange the intervals in something like the order shown in Dr. Preyer's table, and in something like the order indicated by the tree of consonances which I have described. The smallest impurity is detected in the unison where the sensitiveness is somewhere about 1 : 1,000 or 1 : 1,500. The octave follows the unison with 1 : 500 to 1 : 1,000. The fifth follows the octave. The fourth should probably be grouped with the major third and major sixth, and these three may be reckoned as causing a sensation of impurity when the vibration number of the upper tone of the consonance is 1 : 200 out of tune. The minor third and sixths come last of all. Much of the interest of this inquiry centres about the thirds and sixths, for these are the intervals most palpably deranged by equal temperament. In equal temperament these intervals are deranged by an amount easily appreciated by any good ear even in simple melody. In the case of the major third the derangement is over two and a-half vibrations in the 2-foot octave; in the sixth four vibrations. We have seen that one and a-half or two vibrations of error produce an appreciable impurity for these intervals. Any temperament, therefore, which would be satisfactory physiologically, even for melody, must reduce the errors in the thirds and sixths to at least half the amount which occurs in equal temperament.

The degree of harmoniousness of any consonance, therefore, is some guide to the amount of derangement which that consonance will suffer without its purity being appreciably affected. The principle by which the consonant intervals are perceived seems therefore to be that conjectured by Helmholtz and put by Mr. Ellis in the following way—" the remembered identity of a partial tone in the second note with a partial tone in the first." Dr. Preyer has had some trouble in finding a solution for this order of appreciation, for he says—" after many futile speculations I came to the view that the sensitiveness to the purity of a consonance increased with the frequency of its occurrence " (in the natural scale of harmonics); for instance, how many octaves occur to the fifths, how many fifths to the fourths, &c. Dr. Preyer does not explain why he rejects the more probable theory that appreciation depends on the strength or defining power of the lowest pair of coincident or common partials. On this principle the relative sensitiveness for the consonances is, I think, quite explained. The higher the common partials, they are of course the weaker, and the more hidden by the stronger lower partials, and therefore the less likely are small derangements of consonance to be noticed.

I am too little acquainted with the technicalities of keyed instruments to suggest any measures by which the difficulties connected with temperament may be removed. This subject has received much attention at the hands of such men as Helmholtz, General Thomson, Mr. Ellis, and Mr. Colin Brown of our own city. The difficulties in using such enlarged and complicated keyboards are not so great as at first appear, and the succession of chords on such instruments is described as extraordinarily harmonious.

But if tempered are so distinguishable from just intervals, as these experiments go to prove, then the continued use of tempered intervals must damage the appreciation for natural intervals: "Evil communications corrupt good manners." I believe I have seen this effect when testing pianists for intervals. In any case, in teaching to sing, tempered instruments should be avoided. Perhaps the commonest way of teaching to sing is by causing the learner to imitate the air played on a piano. If this method be adopted the instrument should be tuned to just intonation on one key, or two or three instruments should be at the disposal of the teacher, each tuned on a separate key to just intonation. I cannot but think that the tonic sol-fa-ists, by avoiding the errors of temperament, have done something to preserve the sensitiveness of the ears of the present generation.

The Audiometer was made by Mr. Brook, Organ Builder, London and Glasgow. For valuable assistance in the experiments with the Siren, I have to thank Mr. A. Scott Younger; and for similar help in the tuning of the Audiometer, Mr. Wm. Schofield.

DESCRIPTION OF PLATE V.

Fig. 1.—*A*. Audiometer complete.

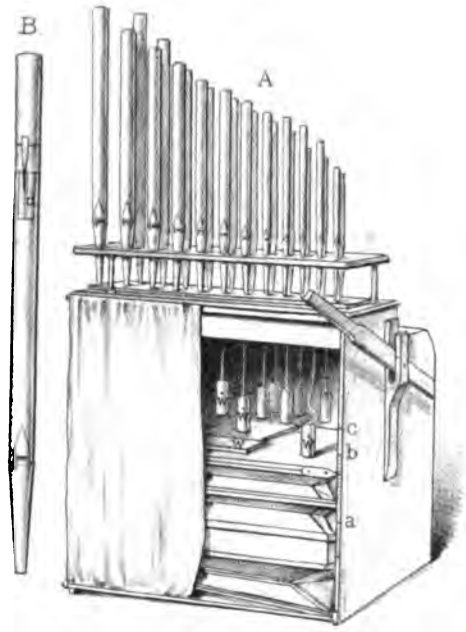
B. One of the larger pipes, in which a movable top is seen, with its pointer against the millimetre scale *d*.

In *A* the bellows is partially exposed, and the constant weight (*W*), together with the auxiliary weights (*W'*), are seen.

Between *a* and *b* the pressure is constant; from *b* to *c* it decreases. The position of the Siren is shown at *S*.

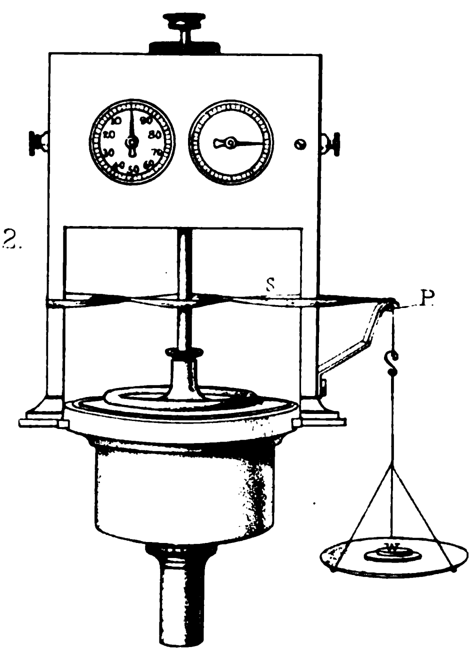
Fig. 2 shows the Siren. The silk-cord brake is shown at *S*, passing over the pulley *P*, and carrying the weight *W*.

Fig. 1



Scale-about ½ Inch to 1 foot

Fig. 2.



About ⅓ Actual Size

XVIII.—*On Mutual Gables*. By JAMES HOWATT, I.M., Measurer.

[Read before the Architectural Section of the Society, 18th March, 1889.]

I HAVE been asked more than once to read a paper on middle or mutual gables, but up to this time had resisted; the great difficulty being that the difference between one gable and another was often minute and interminable. Having now agreed that I should speak, I beg to say that I shall not forget the capabilities of the Society I am addressing, and that as far as possible general principles will be stated, the minutiæ being left to the experts who are perfectly able to grapple with them.

I was very much pleased when I found that our intelligent and earnest Secretary had set down the words "Mutual Gable" in the title for this paper, as I am satisfied from long experience that it is from ignoring or misunderstanding this term that many of the difficulties occurring between proprietors of mutual gables have arisen. But why should it be so? The gable is intended for a mutual benefit to both parties, and not for one of the parties only.

When, therefore, a proprietor is about to build a mutual gable, the possessor of one-half of which he may not know, he should instruct his architect to see to it that the proprietors on both sides shall be equally served, that fire-places, presses, and recesses shall appear on both sides alike, and that where there is a slope in the level of the street the difference should be calculated, and the levels of fire-places and presses made to harmonise thereto—that is to say, to adjust in fit proportions the levels for each. On the other hand, if the new proprietor should determine to increase the height of his flats from that adopted by the person erecting the gable, and which may have been erected in harmony with others in the same range, he is by no means entitled to ask these to be altered by the builder of the gable to suit his requirements, but must do so at his own expense—increasing the height of the gable if need be, also at his own cost. Or he may go deeper, say, to form a half-sunk flat, owing to the rapid fall in the street; here, again, if the first party has gone on fair grounds in erecting the gable the second party can have no claim on him to build, or pay for a sunk flat to suit him, but must do so at his own expense.

Again, when the number of vents used by each proprietor is different, say, six by one and seven by the other, the cost to each is simply ascertained by adding the cost of the vents, the ashlar of the gable top, and the chimney cans; and charging one party with $\frac{6}{13}$ths and the other with $\frac{7}{13}$ths of the whole cost.

Some nice questions come in here, as in the case of a purchaser who desires to increase the width of his tenement, but which, of course, could not be known by the person who built the gable; the situation of the purchaser's fireplaces, presses, &c., might not exactly suit his needs, and it might be a question whether he might build the addition to the width of the gable in line with that already built, or wholly on his own ground. Of course, if the builder was made aware before building the gable that his neighbour intended to do this, he might be able to serve him effectually without doing himself any disadvantage.

It is generally some difficulties of this kind that start up and cause disquietude in the settlement of such gables.

Again, sometimes difficulties arise from want of thought. The gable may be fairly built, but in the case of a tenement with front plot of ground, the dividing parapet wall with cope and iron railing may be built and set up, wholly on the first builder's ground. Now, in such a case, he would be bound to take down and rebuild the parapet wall on the mutual ground, or lose his claim for any part of the expense.

Other difficulties arise from the architect for the second tenement using different mouldings in ornamenting his front wall; these, however, are generally of small moment, and should never cause any difference between parties.

Another point of some importance is the question of rates to be charged by the first from the second proprietor of the mutual gable. If the first proprietor builds when rates are high, and the second comes to possess his half of the gable when rates are low, which of the rates are to be applied to that half of the gable which is now sold? I am aware that there are differences of opinion in regard to this question, but I have always held that the second proprietor could with justice say to the first, "Here is my estimate for the tenement I am building and for the gable I am erecting, and I am ready to pay the same prices to you." But, besides, it is very likely indeed that the estimate or measurement for the erection of the mutual gable at first may not be forthcoming, and we are landed in a sea of troubles, one man saying that the rates were so-and-so at that date, while another would assert that they were 20 or 30 per cent. cheaper or dearer. It seems to me not only more convenient, but also most reasonable, that the new proprietor should be asked to pay the same rates for the half of the mutual gable as he is paying for the new gable which he is erecting at the other end of his tenement, thus paying current rates.

I am perfectly aware that in some cases the sum to be paid for one-half of a mutual gable has been referred to a lawyer. This seems to me an upsetting of things altogether. It were as wise to appoint a measurer to fix a point in law as for a lawyer to determine the value of one-half of a mutual gable, as he must call to his aid a measurer or expert to measure the gable, and also affix prices thereto; besides, it is equally plain that the cost of so doing will be greatly increased without any advantage to either party.

As to the question, "When should the second party pay the first party the price of his half of the gable?"—through long years, even till now, the old adage "Pay when you possess" has been the rule, and was acted upon in the case of a mutual gable which I measured on 7th January last. But I am now told that in some cases the feu contract for the ground contains a clause declaring the amount to be paid for the half gable on the ground to be feued. This seems to me a change for the worse. Many of us must recollect mutual gables that have stood the storm for a score of years, some of which are not now and may not for a long time yet be used, the locality having lost its fame, and another district taken up the running, and in the meantime carrying all before it. Please note another question in connection with this payment of the gable at the time of feuing. It may pass out of the hands of the first purchaser into those of another. The first purchaser, who may have bought it for sale only did not look particularly to the question, as to whether the gable had been built for the fair use of the second party, when he shall determine to build. And therefore no errors were found out, because not looked for, and thus a fine crop of lawsuits would be the necessary result, the lawyers being the only persons who would gain in the matter.

You will notice, Mr. President, that I have only spoken as to mutual gables in Glasgow and its neighbourhood, and therefore I have not intermeddled with the ridge-tree question, which I believe in Dumbartonshire and even in Paisley, exercises the wisdom and patience of those who are called to settle, between parties, the cost and rights of a mutual gable. I believe that these peculiarities are, however, dying out, and I say the sooner the better, as some of the claims seem most unreasonable, or at variance with justice.

XIX.—*Proposal for securing Uniformity of Action in the Exclusion from Day Schools of Children coming from families affected with Contagious Diseases.* By Dr. JAMES FINLAYSON.

[Read before the Society, 3rd April, 1889.]

IT is scarcely necessary to take up time in showing the great influence which school attendance exerts in the spread of infectious diseases, not only among the scholars themselves but also among their younger brothers and sisters at home. The experience of parents, teachers, and medical men may be appealed to in support of this generally-received opinion, and the occasional closing of the schools in districts overrun by epidemic disease, of which we sometimes hear, is a practical evidence of assent to this view.

I am aware that some proposals have been made, even recently, to permit the less serious forms of infectious disease to which children are subject, to have their free course so as to wear themselves out, and to allow children, when able to do so, to attend school, although confessedly liable to propagate the infection of such diseases as chickenpox, mumps, or epidemic roseola. It is contended that no precautions can entirely prevent the spread of such diseases, that children are bound to take most of them at some time or other, and that the danger of their spreading is in proportion to the slightness of the ailments; and it is contended, moreover, that the inconvenience, vexation, and loss resulting from the long, enforced seclusion of many healthy children coming from families thus affected is greater than any harm arising from the spread of the diseases named, which are almost always of a trivial character. Without stopping to discuss the amount of truth there may be in such views, I hold it obvious that the whole tenor of our current ideas and practice in sanitary matters is opposed to this partial method of dealing with the difficulty. So long as the President of this Society is Officer of Health for the City, no such method, I presume, will be permitted, and so this theoretical view may be dismissed from the practical consideration of the subject in Glasgow.

Those who have not experienced the difficulty may think that the problem is a simple one. "We desire," they say, "to prevent children with contagious diseases from attending school while so affected, and from attending so long as they are liable to communicate the disease from their own persons, or to carry infection from their homes, although they may be well enough themselves. What is more simple than to secure safety by medical certificates in all forms of doubtful illness known to exist?" In the case of the poorer classes of the community in our city there might be the difficulty of the expense of such certificates, but with regard to the poorer children under the Glasgow School Board there is a system of co-operation between their headmasters and officers and the officials of the Sanitary Office by which infectious illnesses known to the one or the other are mutually reported, and children from infected homes are excluded from school till a clean bill of health is furnished by the Sanitary Office, which constitutes itself the judge in every case. Probably this, as a system, is as good as can be desired, any deficiencies in its operation being due to the inherent difficulty of ascertaining the presence of infection in the families concerned.

But our Sanitary Office in this action is limited by the boundaries of the City, and we all know that infectious diseases pay little respect to burghal divisions. The Govan School Board, with which we in Glasgow are also closely concerned, although evidently from their regulations very anxious to lessen the propagation of disease in their schools, have no *one* sanitary office to appeal to, and so of course they cannot deal with the difficulty as the Glasgow Board do. Moreover, even in Glasgow, our Sanitary Office itself has to make distinctions in dealing with infectious cases and school attendance, for I believe the boys in the High School, which is under the School Board, and probably many of the children in certain board schools in the better localities, are not supervised in this matter as is the case with children attending schools in the more crowded districts. And, further, in the higher social grades of the community the children attending proprietary schools or academies, whether within or without the boundaries of the city, have no supervision from the Sanitary Office or any central authority in this respect. In such cases, however, the difficulty as to the procuring of medical certificates does not bulk largely, and so it might be argued that it is for the headmasters or the proprietors of such schools to insist on medical certificates when-

[illegible] medical [illegible] that the danger of infection is past, or that [illegible] is not one from which infection [illegible]

[illegible] the value of medical certificates, [illegible] a medical man to magnify [illegible] But we must remember that in certificates [illegible] the statement not merely of facts [illegible] but of his opinions on [illegible] the duration and character [illegible] even on matters of fact, [illegible] of facts must be [illegible] authorities and any errors [illegible] medical practitioners. In [illegible] some attempt must be [illegible] Thus the headmaster of a school, [illegible] of scarlet fever, may [illegible] absent from school for [illegible] of scarlet fever, and that the [illegible] accepting the [illegible] accept the opinion [illegible] being over so soon. [illegible] impossible, and that if the master [illegible] be wrong, on the [illegible] such a certificate. But [illegible] is likely to be called [illegible] access to authoritative [illegible] the subject is systematically [illegible] on the other hand, may not have [illegible] on the exact [illegible] to find out, he may meet with conflicting statements, and so he may try to solve the difficulty for himself, judging that in the special case the [illegible] was so mild that no danger was ever even before the date which he decided to name.

In actual practice it is found that a group of medical men, if called upon to fix the limit of the infective period, or of the [illegible] diseases, may give very diverse statements, and this is shown in actual certificates sent in. Such [illegible] in actual certificates arise in part from simple want of knowledge, and from the attention of the writers not having been [illegible] directed to the matter. No doubt they may arise in part from a certain carelessness or indifference, which regards the whole process of certifying in such cases as a form of little importance; but they also arise from the inherent difficulties of the subject. This is well shown in a tabulation of the views of various authorities on such matters. In point of fact, the period of incubation varies considerably in different persons contracting the disease at the same time and from the same source. Thus, Dr. Eyre, of Beckenham, reports an instructive case (*British Medical Journal*, February, 1889, p. 409) where twenty-nine boys were exposed to the infection from coming into contact with a master whose measles rash had not yet appeared. This was on 1st and 2nd May. They were all sent home on 4th May; fourteen of the boys took the disease, the other fifteen being all protected by a previous attack, but their period of sickening varied from 9th May till 17th May. In like manner the duration of the infective period in a child who has had scarlet fever or measles, for example, seems to vary considerably, influenced, in part, no doubt, by the severity of the attack or the presence of complications; and in the case of smallpox and chickenpox the disappearance of the scabs forms a better guide than any mere term in the duration of the disease. Any hard-and-fast date must indeed be regarded as more or less arbitrarily fixed. At the Glasgow Belvidere Fever Hospital, the time fixed, very properly, in my opinion, before a child with scarlet fever is regarded as free from infection, is eight weeks from the beginning of the attack. But it is obvious that in fixing fifty-six days, we cannot say that the patient was dangerous to others on the fifty-fifth day in this respect, and free from danger on the fifty-sixth. It is an arbitrary date fixed in view of known dangers, and fixed so as to be on the safe side. Some, as in the Code of the Medical Officers of Schools Association, have fixed the period for scarlet fever as six weeks instead of eight. This I believe to be dangerous, but no doubt in *many cases* the danger is actually over by the sixth week, or such a view would never have gained the respect which it has obtained.

It is evident, therefore, that even if they were always carefully written there would be room for much diversity in such certificates, if they are to be the mere expression of individual opinion, and the resulting diversities actually lead to the most remarkable differences in practice. When such certificates are supervised by the medical adviser of the school (as is usual in all large boarding schools, and in doubtful cases is not uncommon in some day schools; we have, of course, still more conflicting results; and we may actually see one member of the infected family admitted to school attendance for a week or two before another member of the same family is allowed to attend another school. The natural result of this is a certain conflict between teachers and parents, and the irritation may extend to the respective medical advisers whose opinions are appealed to or criticised. Another result, of course, is to render nugatory the precautions taken by some if equal precaution is not taken by all. One child sent back to school too soon after scarlet fever renders useless all the expense and loss incurred for other three or four children who may have been kept away an adequate length of time for the same disease.

Some such considerations led the Medical Officers of Schools Association in England to frame "A Code of Rules for the Prevention of Infectious and Contagious Diseases in Schools" (2nd Edition, J. & A. Churchill, London, 1886); and in this Code we have, among other things, a table given of the periods after which "a pupil may go home, or rejoin the school" after having had an infectious disease. There is also a table of "Quarantine times after exposure to Infection for the various Diseases."

CODE

Medical Officers of Schools Association.

(Slightly abbreviated.)

Pupils may return if disinfected:—

After Scarlet Fever, - - -	Not less than six weeks from date of rash, IF desquamation completely ceased, and there be no appearance of sore throat.
„ *Measles*, - - - -	Not less than three weeks from date of rash, IF all desquamation and cough have ceased.
„ *German Measles (Rötheln or Epidemic Roseola)*, -	In two to three weeks, exact time depending on the nature of the attack.
„ *Smallpox*, - - - -	When every scab has fallen off.
„ *Chickenpox*, - - -	Do. do.
„ *Mumps*, - - - -	In four weeks from commencement, IF all swelling subsided.
„ *Whooping-cough*, - -	After six weeks from commencement of whooping, IF spasmodic cough have ceased; or earlier, if all cough have completely passed away.

After Diphtheria, - - -	Not less than three weeks: there being no sore throat, discharge from nose, &c.
,, *Ringworm,* - - - -	After special examination.
,, *Ophthalmia,* - - -	Do. do.

CODE.

MEDICAL OFFICERS OF SCHOOLS ASSOCIATION.

Length of Quarantine.

Pupil may return, if thoroughly disinfected, after exposure to infection—

Diphtheria, - - - -	12	days'	Quarantine.
Scarlet Fever, - - -	14	,,	,,
Measles, - - - -	16	,,	,,
German Measles (*Rötheln, or Epidemic Roseola*), - -	16	,,	,,
Chickenpox, - - - -	18	,,	,,
Smallpox, - - - -	18	,,	,,
Mumps, - - - -	24	,,	,,
Whooping-cough, - - -	21	,,	,,

The periods named are based on the duration of the "infective stage" in the various diseases, and on the "incubation period" during which the poison, although present in the patient, is still latent. These periods are difficult to determine, as it is only occasionally that we have the special conditions which warrant an exact conclusion on these points. Great attention has of late years been given to this subject, and the results of various observers when tabulated (as in the sheets shown*) indicate a certain approximation to agreement at least when the matter is looked at from a practical point of view, which demands a margin on the safe side. The figures in the Code already quoted agree very well with the conclusions I have come to myself after many opportunities of judging, with the exception of the period named as infective in scarlet fever, which I think is rather short to be safe in all cases.

These two subjects just quoted from this Code are those which specially affect day schools, with which we in Glasgow are chiefly concerned. Much in other parts of the Code has a practical

* These have been published in the *Glasgow Medical Journal,* May, 1889: —"Collation of Recent Authorities on the Infective and the Incubation Period in Contagious Diseases, with special reference to the exclusion of such cases from Day Schools."

interest only for those dealing with schools having resident pupils. For similar reasons, however, although redundant in some parts, for our purposes, this Code is deficient in instructions regarding other points on which day schools require guidance. Even if we were to regard this Code as perfect, it requires a little adaptation for the use of schools in Glasgow. Thus, we have no information in the Code as to whether children may attend school when a brother or sister is ill in the same house with enteric fever. Of late the exclusion of patients with this fever from our general hospitals in Glasgow has been decided on, after much discussion. Some maintained (as I believe, erroneously) that there was no practical risk in their being received there, but the risk of a healthy child carrying the infection to school from his home, where such a case existed, is certainly much smaller: in the opinion of many it is either entirely absent or quite infinitesimal. But it is on such a matter that teachers and parents would like to have guidance from a Code framed after due deliberation.

Another matter not quite explicitly declared in the Code has regard to the case of children who have themselves had whooping-cough when younger, but whose brothers and sisters may have it now. The Code, indeed, speaks of twenty-one days' "quarantine" for children exposed to whooping-cough, before they can be received into school; but this word "quarantine" might be held to apply to children who are still liable to contract the disease, rather than to those who, having had it already, are presumably free from the risk of taking it again. As whooping-cough often lingers long in a family, it is the more necessary to have definite statements on the point if the other children must be excluded from school, particularly as there is a widespread opinion (no doubt, erroneous) that it cannot be "carried" by the healthy.

It sometimes happens that when scarlet fever appears in a large family separate lodgings or a furnished house are taken, *pro tempore*, for those children who are attending school, so that their education may not be interrupted by the long period of seclusion otherwise ruled to be necessary. In such cases the parents feel much aggrieved if, after being at this expense, the children are not at once admitted to their classes. The Code implies that fourteen days' "quarantine" are required; the parents, however, sometimes argue that this does not apply to those of their children who have already had the disease. It is almost in vain to point out the uncertainty of the actual occurrence of this previous attack, or—admitting it—the uncertainty of its being a protection from the present disease; and as parents may readily enough obtain some medical opinion in favour of their views, conflict and irritation are very liable to arise. It is sometimes maintained that the incubation period of scarlet fever is never more than eight days, and seldom more than five—indeed, weighty authority could be quoted in support of this as an abstract proposition; but, owing to various disturbing elements in the case, it is well known in actual practice that a period of quarantine corresponding to this would be quite unsafe, unless under conditions which can seldom or never be counted on in the management of day schools. In this way the heads of schools, in trying to do their duty by the children entrusted to their care, are liable to offend some of their clients, and to suffer grave loss in consequence; while the parents of other children in the same school may at the same time unjustly accuse the managers of laxity in taking back the children, even when all needful precautions have been fulfilled. In this way a double irritation is caused, and perhaps both sets of children are ultimately withdrawn from the school in disgust.

It has seemed to me that much of the annoyance almost inevitable under our present system might be lessened, or almost abolished, by the formation of an authoritative Code adapted for day schools. This Code would take much the same position for high schools, academies, and private schools, which our sanitary offices take up in the ordinary board schools in the poorer districts. The exact dates and conditions for the various diseases, and for ordinary well-known complications arising in families, could be specified in such a way that parents and teachers alike could understand them. They might be printed in a condensed form on schedules provided for the medical certificates to be written for the individual case, and this would create a uniformity in action at present sadly wanting. With definite specified conditions provided for, and with uniformity of practice, parents would know that when their children were excluded from school the action was not brought about by any extreme or fanciful views on the part of the head of such an establishment, or of the medical adviser; and, equally, that in admitting children under the conditions specified there was no reprehensible laxity. With such an open method of dealing with the subject parents would no doubt feel it to be their duty to conform honourably to the regulations agreed to, and there would be less danger of illnesses being concealed in case of extreme views being acted on. I fear such concealment is sometimes practised at present.

In framing such a Code, however, a certain appearance of authority is required. In the case of the large English schools, this authority is afforded by the "Association of the Medical Officers of Schools." The sense of authority is requisite because, as already explained, the subject does not admit of absolute and definite statement as a matter of scientific fact. We have to deal with this complicated question of infection as practical men, fixing limits known to be arbitrary, but selected as being safe; framing our regulations in view of all the errors and complications known to arise in actual practice, and not merely deduced from our ideas of infection, and of its incubation period or its infective period in the individual. If the whole of our population, constituting Glasgow as we understand it, were under one sanitary authority we might entrust to our Medical Officer of Health the drawing up of a memorandum for the guidance of all schools, whether proprietary or not; and the fact that the Officer of Health had legal power to give effect to his recommendations, would give a sense of authority likely to be respected.

As this state of matters has not yet come within sight, it occurred to me after turning over several plans in my mind, that this society might appoint a small committee, nominated by, and including, our President, or by his Council, with instructions to invite a representative from the Glasgow and the Govan School Boards, and from other educational bodies such as the Educational Institute and the Teachers' Guild. In this way a committee well acquainted with the difficulties would be constituted, and of course, this committee would have power to add to their number such medical men as they desired for special advice, or they could obtain technical advice in any way deemed best. The Code of the "Medical Officers of Schools Association" would form a basis for this undertaking rendering the work comparatively simple.

XX.—*The Wiring of Buildings for Electric Light.* By J. D. F. Andrews.

[Read before the Society, 20th March, 1889.]

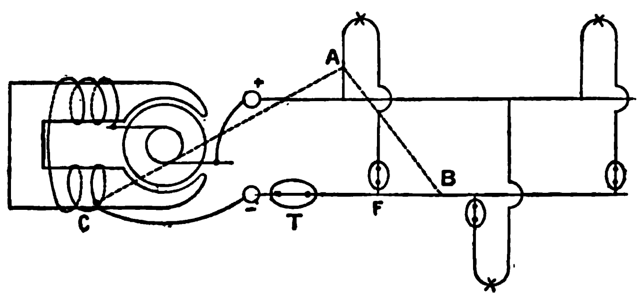
The first points for consideration in devising a wire system for electric lighting are—What contingencies will be met with that may affect the system, and what faults will arise in it after its introduction.

Through past experience it has been found that the practical pressure of electricity for electric lighting is (within 50 per cent. either way) about 100 volts, the 100 volts being most generally adopted. The chosen conductor is copper, and the most widely adopted insulation is india-rubber; in many modified forms the insulated conductors are usually protected and held in position by wooden casing. One object of insulation is to protect the wire from the evil effects of moisture, which sets up chemical action in the conductor. The result of the electrolytic and chemical actions on electric light wires is to thin them and make them insufficient for carrying the current, and consequently they become heated; this may even lead to the rupture of the wire causing an "opening circuit." This effect is about the most difficult and dangerous fault to contend with. It is usual to lay the electric light leading wire in a groove in the casing contiguous and parallel to the return wire. Water often saturates the casing between them, and when the insulation is poor the electricity will pass through the moistened wood and char it, often setting it in flame. Faults such as this, where a great leak is taking place between the wires, are called "partial short circuits," and are equally difficult to avoid, and as dangerous as opening circuits. The study of the insulation of the wires is therefore obviously of great importance. Most of the results in good insulation were obtained by telegraph engineers before the electric light business was started; but in the new business these results were almost entirely ignored. Great insulation was then not considered necessary, and special covering for the wires was devised of a cheap and poor quality, which, it is greatly to be regretted, has continued in use by many contractors to the present day. As previously stated, india-rubber is the base of the insulation of most electric wires—the purer the material the better the insulating properties—but pure india-rubber is easily influenced by air. At first it gets hard, and in course of time changes to a soft, sticky state, when it is useless as an insulator. Pure india-rubber is still the foundation of insulator on the wires, but in the very best qualities it is protected from the atmosphere by an outer coating of what is known as vulcanised india-rubber. Such qualities of insulation consist of, first, one or two lappings of pure india-rubber, then a layer of rubber mixed with such minerals as soapstone, over which again is laid a coating of rubber, mixed with a large proportion of sulphur. The wire, with its three coatings, is now subjected to a high temperature in a vulcan by means of steam, through which the rubber and sulphur combine, while any surplus is absorbed by the middle coat, which is called the separator. Such is the insulation of the best-quality wires. The inferior qualities, and those most generally used, are insulated simply with pure rubber and cotton serving, with ozokerite or other compound tape laid together in many different ways, according to the device of the makers. The compound tape is supposed to protect the pure rubber from the air, but it only plays this function to a small extent. The usual *reliable* life of such wires is from two to three years; and not being reliably waterproof throughout their length at any time, there is always danger of failure through moisture. Vulcanised india-rubber-covered wires of the class above described—there are many inferior kinds—is perfectly reliable in water or air for a great number of years.

The next contingency that has to be contended with is mechanical damage. The wires being more or less flexible and the covering soft they are easily damaged. This difficulty is usually met by casing the wires in wood. Such casing has the disadvantage of harbouring moisture. Another method of protecting the wires is that of sheathing them with an outer covering of wire, as introduced by the writer some years ago in ship lighting. This method protects the wires much more effectually than casing, and does not harbour moisture. Iron pipes have been used in many cases, and are an excellent protection; but moisture collects in them, and if there should be a fault in the insulation it is sure to find it.

There is another fault besides the opening circuit and partial short circuit not yet touched upon—namely, a "dead short circuit"—or a direct contact between the opposite conductors. Short circuits usually happen in the fittings when the opposite conductors are necessarily brought nearer each other, and at these points the insulation is generally much thinner and poorer. Short circuits also often happen where the wires cross, frequently by contact with gas or water pipes, which make very complicated faults, because the two wires usually touch the pipes a distance apart, which will be better understood by reference to Fig. 1. Suppose the current to leave the dynamo by the positive wire, pass to the lamps by the branch wires, and back by the negative branch wires through the fuse F and the negative main to the machine. Suppose, now, the positive branch becomes connected to a gas-pipe at, say, A; this would not indicate itself in any way, and the installation would of course continue working just the same until the opposite wire got connected to the gas-pipe, say at B. Now the current will become excessive—more than the branch wire can carry without getting dangerously hot—before the main fuse T melts. In the above description it is assumed that there is a safety fuse at F, but it will be observed that the short circuit has bridged the wire in which it is inserted, and it is consequently useless. To avoid the excessive heating of the wires with such faults as are above referred to, it is necessary to have a fuse on each wire. Under such circumstances, when a short circuit such as that described between A and B takes place, the + fuse would immediately blow and prevent danger. Let us again assume that there are fuses only on the negative wires, and we will see there might have been even a worse fault. Again, supposing a connection at A with the gas-pipe, which is, of course, connected to

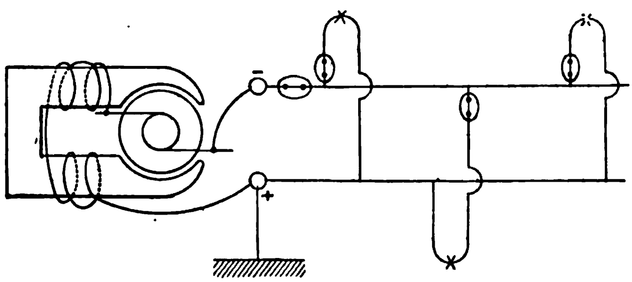
Fig. 1.



the earth, we will assume the second connection to take place in the dynamo field-magnets at C. The current will now traverse the positive wire to A, thence to the gas-pipe to earth, and back to the dynamo. This route is a short circuit, and one moreover that bridges both branch and main fuses, which we have assumed to be only on the negative wire, as is still the practice of some contractors. The consequence of this short circuit is similar to the one from A to B, but worse, because there are no fuses at all left to protect the system. Of course with another main fuse on the positive wire such a short circuit could not continue.

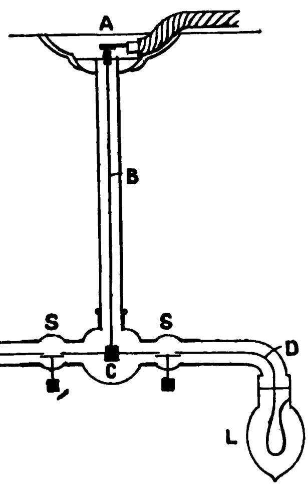
There is, however, objection to the multiplication of fuses; they are a danger themselves sometimes, such as in the case of a partial short circuit that does not increase the current sufficiently to melt the fuse, but quite sufficient to heat it to a degree dangerous to any inflammable material in the neighbourhood, and it may continue in this condition some little time before it fuses, especially if it is a large one. Another point of danger from a fuse is that when it melts it throws out sparks of molten metal. Of course it will be said that the evils in fuses can be reduced by proper construction. That is true; but it is decidedly better to avoid, if possible, numerous points of danger in an installation resting on special construction or the care of an attendant for their prevention. We will consider later how this to a certain extent can be achieved.

FIG. 2.



In the foregoing we have considered mainly the contingencies or dangers arising from the introduction of electric light into buildings, and we may summarise the main points as being an opening circuit, a partial short circuit, a dead short circuit, and the fuses. We have considered the dead short circuit to be met v the fuse, although a new element of danger is introduced, which, however, is much less in degree. This new element of danger can be reduced to one-half by connecting one of the leading wires, say the positive, to the earth and the gas and water mains, it being only on account of the latter that it is otherwise necessary to provide a fuse on each wire. Fig. 2 will show this more plainly. The current leaves the dynamo by the positive terminal, and meets at once a connection to earth and the gas and water mains, then proceeds by the positive wire to the lights and back to the dynamo. This connection to earth is wilfully effecting the fault we supposed might happen, as in Fig. 1; but in making the connection to earth we are careful to do so with that wire which has not got the fuses inserted in it, which is contrary to the action of the fault in Fig. 1. Now, if any of the negative wires come in contact with the gas and water pipes a fuse must instantly blow, as if the two conductors themselves had touched. All the electric light fittings would in this case be connected with the positive wire, the negative wire

Fig. 3.

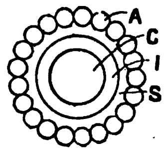


passing down the centre of the tubes. There being in the fittings only a single wire which can be heavily insulated and made stouter, there is an additional safety against short circuits, or the fuse melting, besides the very great advantage of being able in a very simple way to wire each part of an electrolier or fitting. Fig. 3 illustrates how this is effected. The current travels from the contact A down the wire B, through the contact C to the switches S S, by the wire

D to the lamp L, and back by the brass of the fitting to the ball and socket at the top, and away by the earth wire. The wire inside the tubes is never smaller than No. 14 S.W.G., and the contacts are made with a strong small spiral spring. The contact at the ball-and-socket joint projects through, and being a box spring it gives and takes with the swing of the fitting, and scrapes on a fixed brass plate in the roof plate. Single or universal joints are quite simple to construct with this system within the same dimensions as for gas, whereas with the two wires passing through the fitting this is impossible. This method of connecting one of the wires to earth is best called the earth system; it is, however, often called the single-wire system, because in its application to ships the hull of the ship is used as the return wire. In buildings, however, two conductors are required; and as it is important always to be able to distinguish between the negative wire in which the fuses are inserted and the positive wire which is connected to earth and all the electrical fittings, the positive wire is coloured red and the negative wire black. The object of connecting the positive wire to earth is that red-coloured wires are usually inferior in insulation quality to black wires, and it is not so important that the return or earth wire should be so highly insulated as the leading wire.

We now come to the consideration of means for minimising those most dangerous faults—opening and partial short circuits. Except the means proposed by the writer in the following paragraph, no attempt has been made to treat these faults except by good workmanship and material. The proposal the writer makes is to universally adopt the sheathed or armoured wire system devised by him some years ago for use in the exposed and damp places on board ships, using the earth-wire system, and now extensively employed for that purpose. The virtue of this system is that all faults, partial short circuits, and opening circuits, are reduced to dead short circuits. Fig. 4 is an enlarged section of an armoured

Fig. 4.



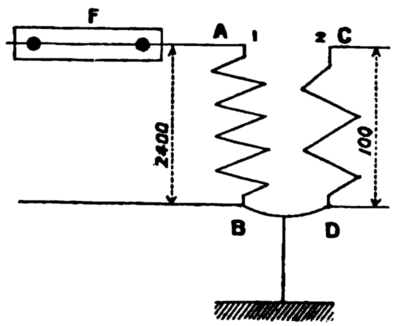
wire such as is now in use; C is the copper conductor. It is covered with vulcanised india-rubber insulation, I, of the highest class, with a serving of jute and special compound, S, between it and the iron armouring, A, which is a great many times larger in cross-section than the copper conductor. Care is taken that it is always more than seven times larger, this being about the difference in electric conductivity of the two metals. It will be understood that the copper wire is the lead and the iron wire the return. It was assumed in devising this system that an opening circuit in the outer conductor was very unlikely to take place, and so it has been found in practice; it is possible, however, that the inner conductor, through undue strain or a flaw, might have an opening circuit in it, and if such were to take place the immediate result would be that the heat generated would destroy the insulation between the two conductors, and at once effect their fusion together and a short circuit. As a matter of fact, however, short circuits in this system have in practice been comparatively few, and there have been no opening circuits or partial short circuits. How many of the short circuits were due to such faults it is difficult to say; the cause of some were doubtful.

The writer is not aware of any new danger or contingency being introduced with this system of concentric wiring, although he has heard that some people object to it, and in fact to any system in which an earth connection is introduced; but he has still to learn upon what grounds the objection is based.

In addition to the advantages already referred to, there is another of not the least importance. The electricity being entirely enclosed within the outer conductor, and the electric pressure being only from the centre point to the outer conductor, it is impossible to get a shock through anything more than a very small portion of one's flesh, such as the finger, except by wilful contrivance.

It is advisable before closing this subject to consider how a system of wires supplying a town would be affected by an earth connection of one of the conductors. With any system of supply embodying the series system, I may generally say it is not advisable to employ an earth. I have expressed this point broadly, as it involves complex considerations which would take long to make quite clear. But with all systems on the parallel system there are many points favourable to an earth connection, some of which can be gathered from foregoing descriptions. It is more important for us to find out whether there is any objection to its use, and with this in view Fig. 5 is placed before you. It

FIG. 5.



illustrates a transformer with its primary leads and an electric pressure of 2,400 volts at the terminals A and B, where they join the primary circuit 1, of the transformer. F is a fuse in the primary circuit; 2 is the secondary circuit of the transformer, between the terminals C D, of which there is represented a pressure of 100 volts; the terminals B and D of the circuits of the transformer are connected to earth, and consequently connected together. The writer is unable to find any danger in thus connecting the 100-volt pressure circuit to the 2,400-volt pressure circuit. Nobody could get a shock to earth, because the pressure between the return wire and earth is reduced to *nil.* The next point is this—Is there any greater probability of the insulation of the transformer breaking down because the circuits are joined together at one end? This seems to the writer to be answered by a simple calculation; with the earth connection there is no pressure at one end, but all the pressure whatever it is at the other; with no earth connection the pressure is alike at both ends, but at each it is only half the total. The result in both cases is the same. Suppose a connection did get made between the terminals A and C in addition to the earth connection, the 2,400-volt circuit would be simply short-circuited, and the fuse, F, would melt. There is, it is true, a very remote possibility of danger in the event of the great improbability of three circumstances happening in succession—namely, first of all, a connection between the terminals A and C as well as the earth, then the fuse, F, not melting, and thirdly, the circuit of the secondary of the transformer to open between the terminals, and thus put the 2,400-volts pressure on to the lamps direct, which would, as a matter of course, immediately gasp their last.

There is one other circumstance worthy of mention in favour of the earth connection. Should the wire system at any time be struck with lightning there is at once a safe connection to earth, instead of having to pass through a highly insulating material, as when there is no earth connection. Lightning has already been known to strike overhead electric light wires and discharge itself through the dynamo to earth, to the imminent danger of the machine.

XXI.—*The Garnethill Scarlet Fever Epidemic: A Microscopical Investigation regarding its Cause.* By Dr. NEIL CARMICHAEL.

[Read before the Society, 3rd April, 1889.]

(PLATE VI.)

ON 15th March of last year an epidemic of scarlet fever and of scarlatinal sore throat broke out in Garnethill. The source of infection was clearly proved to be the milk sent in from a particular farm. In connection with this farm, no trace could be discovered of any illness in any way resembling scarlet fever existing at, or shortly before, the outbreak of the epidemic. On 27th March, Dr. J. B. Russell, our Medical Officer of Health, found on the teats of two cows on this farm ulcers and scabs which were indistinguishable from those found on the teats of the cows in the Hendon epidemic, as shown in water-colour drawings. Dr. Russell and Principal M'Call had the cows removed to the Veterinary College for observation. At this stage the animals came under my observation. Both animals were in fair general condition, but were copiously casting skin and hair—in fact, desquamating freely, as a child does after scarlet fever. A calf fed on milk obtained from one of these cows was seized with an acute febrile illness, which seriously endangered its life. This febrile attack was followed by desquamation of the hair and cuticle of the calf.

Such is a very brief account of the epidemic, and of the appearance of the animals up to this point. For fuller details, for statistics of the epidemic, and for the evidence proving that the milk of these cows was the cause of the epidemic, I would refer you to the report presented by Dr. Russell to the Magistrates and Council of the City, which you will find in the *Sanitary Journal* for May 16th, 1888.

One of these cows, which presented more marked indications of disease than the other, was selected for special observation. It was desquamating very copiously; its milk was scanty, and had in it numerous small hard curds; its urine was of very high specific

Fig. 1.

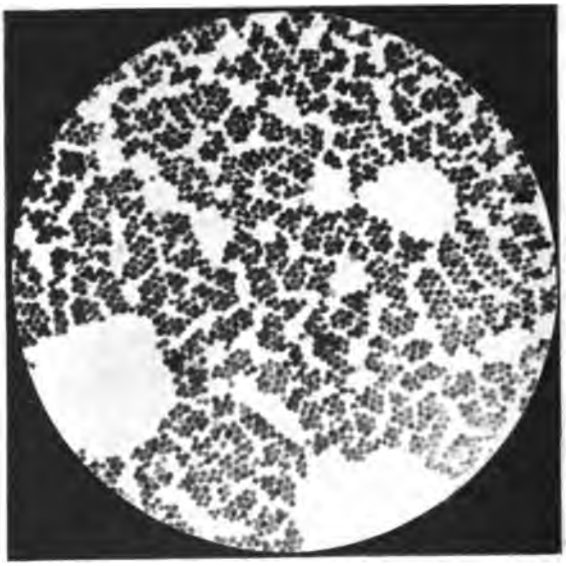
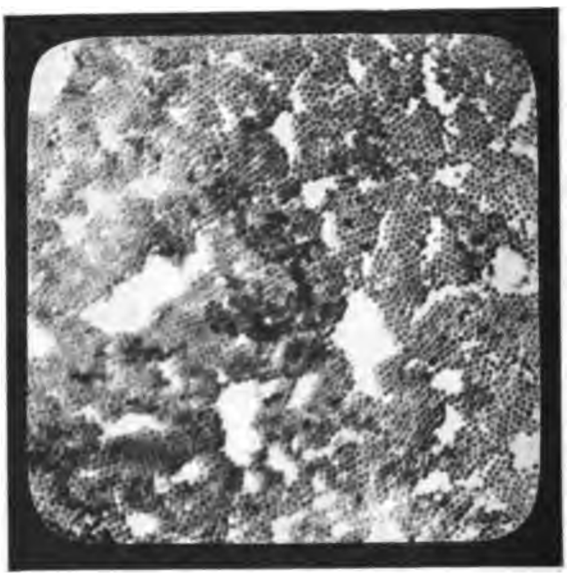


Fig. 2.



gravity, and heavily loaded with urea, and it contained at times kidney tube casts. Professor Cooke, of the Veterinary College, who conducted numerous analyses of the urine, stated that the quantity of urea which he found in it was larger than he had ever before found in any cow's urine.

The milk which this cow yielded was found to contain small curdled masses, and these, which sometimes partially plugged the teats, came out in milking with a sudden jerk as a cork comes out of the neck of a bottle. The curds, examined under the microscope, were found to contain micrococci in short chains.

To obtain for examination and for culture some of the milk perfectly free from external contamination, a flask with glass tubing and india-rubber tubing connected to a silver canula which had an opening in its side, were sterilised by prolonged boiling. The canula and india-rubber tubing were covered with sterilised cotton wool. A teat of the cow was washed with a solution of carbolic acid, and the canula was pushed through the cotton wool and through the teat into the udder. This was kindly done for me by Principal M'Call of the Veterinary College, so carefully that no contamination was possible. A clip which had closed the india-rubber tubing was now withdrawn, and the milk flowed freely into the flask. When sufficient had been obtained, the india-rubber tubing was tied firmly, and the canula removed. Small quantities of this milk were placed on veal soup thickened with Agar-agar, and placed in the incubator. They gave rise to a growth of a creamy-looking mass, which spread with considerable rapidity. Examined under the microscope this was found to consist of micrococci of one kind—evidently a pure culture. They were arranged in zooglea-like masses—like frog spawn—and were subsequently found on careful measurement to be about the 40,000th of an inch in size. (Fig. 1, Plate VI.)

A little blood from the deeper layers of the skin of the calf which had been fed on the milk of this cow, and which was at this time desquamating slightly, was drawn into a capillary glass tube, antiseptic precautions being maintained. The blood was, like the milk, placed on veal soup and Agar-agar, and kept in the incubator. In a few days an abundant creamy-looking growth was observed in each flask. In naked-eye appearances, and in mode of growth, it was quite indistinguishable from the growth obtained from the milk. Examined under the microscope it was found to consist of only one form of micrococcus arranged in zooglea masses. They were found to measure about the 40,000th of an inch in diameter, and were quite indistinguishable from the micrococci obtained from the milk. (Fig. 2.) So that the cow which was suspected of having caused the scarlet fever epidemic was found to contain in its milk micrococci (or microbes). The milk of this cow produced in a calf fed upon it an acute febrile illness, and the production of this illness was coincident with the appearance in the blood of this calf of a microbe altogether indistinguishable from that found in the milk with which it had been fed, and which had evidently caused the iilness.

Such, briefly, is a history of the organisms. We now proceed to consider the mode and the results of photographing them. A verbal description of minute organisms by an observer is subject to the objection that it is qualified by his opinions and his preconceived ideas. A drawing is largely open to the same objection, and any one acquainted at all with bacteriology must know that drawings of the same object, such as the tubercle bacillus, made by different observers, are very diverse. Koch, after drawing attention to the difficulty of accurately conveying the appearances of bacteria by drawing or verbal description, says, "for these misunderstandings which one frequently observes in microscopy, and which have exercised the most deleterious influence on the progress of the science, there is only one remedy, and that is photography."

I propose shortly to sketch the method employed in securing the photographs which have just been exhibited, and pointing out how the several difficulties have been overcome.

It will be readily understood that objects such as a fly's foot or proboscis, or even objects the size of blood corpuscles, are more easily observed, and much more easily photographed than objects the 40,000th of an inch in diameter. A photographic image is obtained from the shadows or from the colours subjected to the light, but it will be readily understood that objects of such minuteness as these micrococci lying in single layers—in which condition only can good photographs of them be taken—cast a shadow so slight, and exhibit so thin a layer of a colour in itself very delicate, that special means are necessary to intensify the image. In the first place, the organisms taken from a pure culture are spread thinly on a cover glass, and stained with a strong solution of an aniline dye. Magenta and Bismarck brown have yielded the best results; blue, orange, and yellow stains do not photograph well. It is advisable to stain very deeply, and then to clear away all superfluous dye by washing with methylated spirits. The specimen should then be mounted in Canada balsam, and this allowed to harden. But if it be desired to photograph at once, without waiting the time necessary for the drying of the balsam, then a filtered solution of gelatine still warm may be placed on the slide, and the cover glass placed on this, and pressed down with a spring clip. In a few minutes this will be quite firm enough for all the necessary manipulations. This is a temporary mounting from which the specimen may be recovered for permanent mounting in Canada balsam, by immersing for a few minutes in hot water, so as to again liquefy the gelatine. The specimen, deeply stained, is now placed on the stage of the microscope. In the preparation of these photographs the instrument used was one made by Zeiss, of Jena, a $\frac{1}{12}$-inch apochromatic homogeneous-immersion lens being employed. The eye-piece used was a Zeiss' No. 4 projection eye-piece, and an Abbé's condenser was attached to the sub-stage. In its working this combination is exceedingly perfect. The eye-piece of the microscope is fitted into the lens tube of a bellows camera, but is not in actual contact, so that any vibration of the camera will not affect the steadiness of the microscope. The microscope table must be very steady, but need not be large. That which was employed had a focussing arrangement connected with the fine adjustment, so arranged that the focus of the microscope could be finally adjusted at the focussing screen of the camera. Illumination was obtained from the oxy-hydrogen lime-light, and although a good paraffin lamp may suit with a very long exposure, the results are not so good. The focussing can be more perfectly secured and the picture taken more quickly and more sharply by the lime-light. But one difficulty which frequently presented itself in the earlier attempts with this instrument was, that a field well-focussed to begin with somehow got out of focus in a few minutes. This was very perplexing, and was at first attributed to unsteadiness of some part of the apparatus. But careful observation showed that this effect was the result of the partial melting of the Canada balsam or gelatine, by the heat concentrated on the specimen. To obviate this, a globular flask filled with a saturated solution of alum was placed between the light and the microscope. This served the double function of absorbing the heat rays and of focussing the light rays like a bull's-eye condenser. No further trouble was experienced in securing a steady field, the focus being perfectly maintained. The plates used were Thomas' dry plates. These are very thick; some thinner plates were used in the first instance, but halation of light which passed through the film clouded the photographs seriously. The thick plates were free from this objection, especially if the back of the plate was painted over with Gihan's opaque paint. The length of exposure required varied, of course, with the individual specimen employed — depending on the amount of contrast obtainable between the deeply-coloured organisms and the medium in which they were mounted. Sometimes one minute or less would be found sufficient, but usually six to eight minutes were required. In developing the negative plenty of time should be allowed, no attempt at forcing quickly being successful. The plate may lie from 15 to 45 minutes, or longer, in the developing solution, and only at the last may be slightly forced by adding more ammonia. Finally, if the picture is found to be too thin for printing it may be intensified by immersing in Edward's intensifier, which is a solution of iodide of mercury in hyposulphite of soda. The printing is carried out as usual. Good enlargements may be obtained by using Eastman's bromide paper.

The mode of measuring the objects, and of determining their degrees of enlargement in the photographs which was found best, was to photograph the thousandth-of-an-inch of the micrometer slide, under the same conditions in which the photograph was taken.

The micrococci were found to be about the 40,000th of an inch in diameter. They were uniform in size. Those cultivated on gelatine were found in zooglea masses, while those cultivated in liquid, such as soup, were found in short chains. The micrococci found in the curd of the milk were also in short chains, each of from three to five or six cocci.

What are these organisms? and what connection, if any, have they with scarlet fever? To these questions, as yet, no absolutely conclusive answer can be given.

Dr. Klein, in investigating the Hendon epidemic of scarlet fever, found, described, and cultivated microbes, which from his description of them, given in the Sixteenth Annual Report of the Local Government Board (1886-7), seem to be the same micrococci as the one which we have been examining. With cultivations of this micrococcus, Dr. Klein asserts that he has succeeded in producing in various animals a febrile disease having the pathological lesions of scarlet fever. With the organisms which we have found, a slight but as yet quite insufficient attempt at experiment on animals has been made. In one calf inoculation of the cultivation produced a slight febrile illness with a little, mainly local, desquamation of cuticle. But until many more experiments have been made in this direction, it cannot be held as proved that these microbes are either the efficient cause or even the carriers of scarlet fever. Yet their association with this outbreak, under the circumstances detailed, fully justify this preliminary account of them, and this attempt at a permanent record by photography of their several characteristics.

XXII.—*Chile: its Present Position and Future Prospects.* By John C. Rogers, Chilian Vice-Consul.

[Read before the Society, 23rd January, 1889.]

(Plate VII., Map of Chile.)

I felt very much pleased at the visit which Dr. Blackie paid me a short time ago, when he stated that he had been requested, on behalf of the Society, to ask me to prepare and read a paper on Chile.

My pleasure did not arise from a feeling that I could do the Republic anything approaching justice, but from the fact that, here in Glasgow, there were those who knew a little about Chile and were desirous of knowing more.

Considering that I had spent nearly twenty-three years in the Republic, six to seven in the capital, Santiago, and the rest at Valparaiso, I had pleasure in promising Dr. Blackie to do as asked; adding, however, that many of the main points of the paper would most likely be on business. Therefore I trust the particulars prepared will be found to cover items of information which will prove interesting, and ultimately bring about increased business between Glasgow and all the ports of the Republic, north and south.

The run out to Chilé is one of the pleasantest; no steamers are superior to those of the Pacific Steam Navigation Company: they start from Liverpool, and touch at Bordeaux, Lisbon, St. Vincent, Pernambuco, Bahia, Rio de Janeiro, and Monte Video, and in due course they pass through the Straits of Magellan. On the 38th or 39th day they reach the two important Chilian coaling ports of Lota and Coronel, and two days later enter Valparaiso.

My plan to-night, in order to cover the agricultural portion of Chile, situated in the south, as also the important mineral districts in the north, is:—*First*—to start from Coronel and Lota, proceed south by steamer to Port Montt, thence inland on horseback through some of the grain districts to Valdivia and Corral; steamer from which will then again be taken in order to reach the port of Talcahuano, and our journey continued inland by train on to


CALLAO
LIMA
PERU
PACIFIC
COPIAPO
JUAN GODOI
S. ANTONIO
CARRIZAL ALTO
CARRIZAL BAJO
PUNTA DIAZ
YERBABUENA
HUASCO
VALLENAR
FREIRINA
PEÑA BLANCA
CHAÑARAL
LA HIGUERA
RAILWAYS BEING CONSTRUCTED
NITRATE MINES

Santiago, the capital, and Valparaiso, the chief port; *Second*—from Valparaiso we shall take steamer and touch at all the principal copper, manganese, and nitrate ports in the north; then I shall begin to close with the most important of all the nitrate ports—Iquique and Pisagua,—closing finally with statistics as to the export of copper, grain, and nitrate, together with the income of the State; the state of her debt; the paper currency; and the present position of the navy and army protecting her territory.

Chile, as you will observe from the map, is a long and very narrow strip of land lying between the Andes and the Pacific Ocean, covering nearly 45 degrees of latitude, and in breadth between 145 and 160 miles. A model of Chile would show the Cordillera or Andes on the right, between which and the ocean extend a range of hills not quite so high. These hills run from north to south. Southwards the ranges widen out, giving comparatively level land of considerable extent for agricultural purposes.

All the places south were visited by me a year previous to leaving Chile, so that I speak from personal observation.

Coronel and Lota.

These are the most important of the coaling stations. The population of Coronel is 10,000, and that of Lota about 12,000; and as their splendid bays are entered, signs of the essence of commercial life appear in all directions. Nine-tenths of the populations are engaged in the extensive coal mines for which Lota and Coronel are so well known.

The dip of the strata of these mines is under the sea, so that all the pits are close to the beach, the galleries extending for long distances under the bed of the ocean.

The coal is of good quality, and it is found to be a fair substitute for English. It is adopted by the Pacific Steam Navigation Company, by the Gulf and all other lines trading to the coast, as also for the State railways, for domestic purposes, as well as for copper smelting when mixed with English coal.

The details of qualities are, more or less, as follow:—

	Carbon.	Hydrogen.	Oxygen.	Sulphur.	Ash, etc., and Nitrogen.	Total heat of Evap. units.	Evap. power from and at 212.	1 Ton occupies in cubic ft.
Chile, ...	63·56	5·43	14·18	2·50	14·23	100·30	11·68	45·25
Scotch,...	78·53	5·61	9·69	1·11	5·03	141·64	14·65	42·—
N'wc'stle,	82·12	5·31	5·69	1·25	5·11	148·20	15·32	40·50

There is an enormous demand for coal all along the coast. We put it down as from 250,000 to 300,000 tons from England, 130,000 to 160,000 tons from Newcastle, N.S.W., and about 600,000 or 700,000 tons from *all* the native collieries, yearly. These figures give a total of from a million to a million and a quarter tons. The output at Coronel and Lota is from 40,000 to 50,000 tons monthly, and in this we do not take into consideration the quantities used locally for domestic and other purposes. The price for Lota coal placed alongside vessel is $7, or about 16s. 6d. per ton; that of Coronel, which is softer, runs about $6·50, or 14s., both at the exchange of 28d.

The most important of the Lota mines cannot increase its output, and, as fears are entertained that it is giving out, explorations in other parts are being actively carried on. One new undertaking, having pits not far from Lota, is in a very advanced state, and operations will likely be commenced during this year; its output is expected to be 10,000 to 15,000 tons monthly. There is a very remunerative future for enterprising capitalists who have around them active, intelligent engineers, possessing a full knowledge of the many important details of coal mines. In the journey by steamer and on horseback undertaken with a friend, we passed through many districts showing signs of carboniferous deposits, which had been examined, but which were simply unworkable owing to the bad roads and distance from loading ports. These difficulties will soon disappear, Government having just arranged for the construction of ten new lines of railway.

Demand for coals cannot but continue to increase, and at all times it will be in full sympathy with the progress made in the north, particularly at the copper mines and nitrate deposits, and as these may be looked on as in their infancy, it comes to be purely an arithmetical question as to quantity yearly required from Newcastle, N.S.W., and England, after absorbing every ounce which the native mines yield. The total will very soon run up to two million tons.

I look on the present as *the* opportunity for Glasgow experience and push to join together and form syndicates, made up principally of capitalists, and those possessing an intimate knowledge of all the weak and strong points of collieries, for the purpose of sending out practical engineers, with powers to explore the south of Chile for coals, to negotiate the conditional purchase of land, and to bring with them all plans and estimates necessary, in the event of the conditional purchase being carried out. A small portion of the money invested in the gold mines of other countries, put into the south of Chile in the manner just explained, would, beyond any doubt, prove an investment not only profitable to the investors themselves, but also to their children and grandchildren. Many investors do not care to put their money into distant countries, but no fear need exist in this case, as the remunerative position of all the Chilian companies floated in London proves that these enterprises can be well controlled by local boards, investors invariably holding the reins of all details on this side.

Chile has *no* coals in the north, but has immense deposits in the south, and I hold that investors' attention has not been directed to her southern territory, and that her present position in coal is reduced to the simple question — Who is going to take the initiative? that is to say, which of the countries, England or Scotland?

Later on I will draw your attention to nitrate from Chile, an article now, at last, well and most favorably known on the Stock Exchanges of London and Liverpool; and, whilst many declare the enterprise in it the soundest and well nigh the most remunerative in the world, I do not hesitate to say that equally good returns, if not better, in coals are awaiting the foresight, capital, intelligence, and push of investors, be they in Glasgow, London, or elsewhere. Every mail from Chile brings some item of information regarding coals, and very soon I hope to see as much interest manifested in coals as there is at present in nitrate.

At Coronel and Lota there are, in addition to the coal mines, extensive smelting works and foundries, also potteries, bottle works, brick kilns, &c., all steadily advancing; and as a good quality of clay has been found, in layers of a fair depth, near the beds of coal, the certainty is that, by the introduction of money and experienced workmen, a great impetus could be given to each industry.

PORT MONTT.

Lebu is a small port, rapidly taking up an important position, owing to the coal mines, smelting works, and gold mines in its immediate vicinity, as also to its being one of the outlets for the wheat and barley grown at some distance inland. Against the port there is its exposed position, together with the poor anchorage which it offers to vessels. From Lebu we pass on to Ancud, capital of the province of Chiloé, and standing on the Archipelago of Chiloé.

The natives of this particular district make splendid sailors, owing to the experience gained in the different canals of the Archipelago. As we leave Ancud the channel gets narrow, and as we approach Port Montt the vista is simply grand; the windings and turnings, the luxuriant vegetation and the flowers, all tend to bring to one's recollection the Kyles of Bute and some parts of the Clyde from Bowling upwards. Then the grandeur of the Cordilleras, as they gradually open up as the gulf widens, revealing the chain in some of its finest aspects, with its peaks, the volcanoes of Osorno and Calbuco, causes the short run to Port Montt to be one never to be forgotten.

Port Montt is the extreme southern port that the steamer calls at. The bay is one of the finest on the whole coast, land-locked, and quite shut in by several islands, forming a natural dock. The Pacific Steam Navigation Company often, when tide and time permit, take advantage of this to beach and clean their steamers, so saving docking expenses at Valparaiso. The inhabitants are all Germans, and till we again join the steamer at Valdivia all our travel inland will be amongst Germans. They ship largely to Valparaiso, bark for tanning ox-hides, wool, seal-oil, leather, beer, and potatoes, but the principal business is in wood suitable for sleepers, pit-props, &c., cut to any length, and of which immense quantities of the former are sent as far north as Callao, and occasionally to Panama.

Port Montt we left by coach at 5 a.m., proceeding up the hill, and making for Lake Llanquihue, so commencing our journey inland, and once more northwards. We drove through large forests, passing what might be called streets of huge piles of timber—railway sleepers, principally. Clearances of ground, extending to from 12 to 20 acres, had been made every few miles. Port Varas on the Lake of Llanquihue was reached in about three or four hours. During the six days we remained at Lake Llanquihue we made a point of visiting a number of the farms, belonging, of course, to Germans; and, considering the condition of the land when the colonists arrived, we found all well under cultivation, and proving remunerative. Here, as elsewhere, there was the enterprising and pushing Scotchman—a Mr. Christie, from Coatbridge. A special visit was made to his farm, distant about fifteen miles. The opening difficulties, which every colonist has to tackle, had been overcome. We found his farm well under cultivation, and stocked with cattle almost equal to the best found in Lanarkshire. The houses were, of course, built of wood, but in other respects little difference existed.

The Lake of Llanquihue is about forty miles both in length and in breadth. We availed ourselves of a small steam launch in crossing, and on reaching Port Octai were pleased to find a friend, Mr. Dartnell, awaiting us with horses. Henceforth our journeyings were undertaken on horseback.

The ride to his farm was through large clearances of land, and we had on each side of us tracts of country, with crops in an advanced stage, extending almost as far as the eye could reach.

Mr. Dartnell's farm was found to be the best stocked in all the south. There we saw, to our surprise, cattle having long pedigrees, imported at a stiff cost from England and Scotland. The pasturage was of the richest, and our stay of a few days was mostly taken up riding and examining his extensive possessions or clearances, all in the best of condition, so proving the truth of the Spanish proverb that "under the eye of the owner the horse gets fat."

VALDIVIA.

The roads from Port Varas on to Valdivia through the different stages or towns—Octai, Concura, Osorno, and La Union—were found in some places almost impassable owing to the bogs and somewhat deep rivers, over which most insecure bridges had been laid of felled timber and branches; other parts, however, were in excellent condition. The country we passed through was well cleared, and at many points vast plains covered with wheat could be seen as far as the eye could reach. Many portions reminded us of parts of Ayrshire. At one farm which we visited, near to La Union, we had the pleasure of seeing all the details of the harvest, from reaping to the grain being carted off bagged for the nearest market port, Valdivia. The grain was found to be clean, very full in ear, and equal to any that we had examined at Valparaiso, or at the grain ports of Chile.

In connection with farming the principal difficulties are means of transit to and connection with loading ports, but the new railway lines already referred to will put everything right. The land is all that can be desired—rich, productive, and well watered. All who understand farming, who are healthy and persevering, if dissatisfied with the returns of their farms in Scotland, should go to Chile—in particular, to the section laid out by the Government.

Valdivia we reached on the third day after leaving Mr. Dartnell's farm. It is almost entirely inhabited by Germans, most hospitable, industrious, practical—and who are all engaged in tanneries, breweries, sawmills, or on farms, &c. The principal brewery and many others are worth visiting, the organisation and completeness of detail being almost perfect.

The quality of the production of their tanneries is equal to, if not ahead of, any of those in France or other parts. The leather is nearly all exported to Hamburg, where it is cut up; part of it is shipped to Glasgow and London, and the balance, which is the finest portion, is sent to Russia for special purposes.

The river Calle Calle, or Valdivia, is the most beautiful in Chile, the banks being clothed with luxuriant vegetation, close down to the water, so that only here and there is a bit of beach to be seen. As regards the upper reaches of the river, they are superb, and are considered by those who have seen both to be fully equal to the scenery of the Rhine. Boating, bathing, and fishing are, during the summer months, carried on to a great extent, and Valdivia is fast becoming to the good people of Valparaiso and Santiago, what Dunoon, Rothesay, &c., are to ourselves. The run down from Valparaiso is by steamer. Only three days are taken up, and what with the sea breezes, the difference in climate, the boating, the many pleasant roads for driving and riding, a visit of a couple of weeks has a wonderful effect, and all return feeling younger and in every way much benefited.

Some of our countrymen, merchants at Valparaiso, are purchasing building sites near to Valdivia, putting up neat and inexpensive summer residences, and in a few years the sides of the river will all be dotted with houses, as are the shores of the Gareloch or Holy Loch.

We leave Valdivia, and go down the river in a steam launch to the small but exceedingly picturesque port of Corral, for the purpose of joining the mail steamer going north. Corral is beautifully situated, and commands the entrance to the Valdivia river, and is certain to follow Valdivia and become one of the most popular summer resorts in Chile. The entrance is very pretty, not unlike that to Rio de Janeiro.

Tomé and Talcahuano.

This closes the trip by land, as far as Valdivia, and here the steamer has to be taken for Tomé and Talcahuano, the grain ports of Chile.

In place of continuing our journey by steamer, we landed at Lota, and after making all arrangements for a coach to take us on to Tomé and Talcahuano, we decided to inspect before starting the grounds or gardens of Doña Isidora Cousiño, who owns, in addition to the coal mines, &c., to which I have already referred, almost every house in Lota. Mrs. Cousiño is the richest lady in Chile. Her house and grounds are situated on one of the hills. About twenty to twenty-five years ago this hill was just like all the others in this section, sandy and without any vegetation. She engaged in England, Scotland, and France, gardeners of the highest intelligence, architects, builders, &c., and in a few years completed a mansion which is replete with all modern improvements, in no detail inferior to any in Europe, while the barren, unattractive-looking hill was converted, at an enormous cost, into one far ahead of the Central Park at New York, or any other which we have yet seen. We examined almost every nook and corner; at every few steps we found cascades, fairy caves, fountains, statuary, with surroundings of unlimited numbers of plants, trees, and flowers—all reminding us of gardens in Rio, in Paris, and in London.

We now commenced by land our journey towards Tomé and Talcahuano, and would here mention that at the present moment the Arauco Railway Company of London are opening up large coal mines about twenty-five miles south-west from Lota. The road by coach is not far from their projected railway. The scenery beyond Lota, and for a considerable distance inland, is uninteresting, but as we approach the river Bio-Bio the dark sandy soil disappears, and we run into a well-watered section with splendid vegetation. This river has to be crossed in large, flat-bottomed boats, and owing to the currents, many detours have to be made, and the greatest care has to be exercised. However, all went well with us, and in about thirty or forty-five minutes we were safely across.

Talcahuano has one of the finest bays in the world. There are two entrances to it, and it affords the best of anchorage as a port of call for ships arriving from the Plate, &c., in ballast, seeking cargoes. This port is rapidly taking an important position. It is also the terminus of the line running from Santiago to Concepcion, and Government are assisting its onward movement in every way. At present they are constructing, and have nearly completed, at a cost of about £600,000, a large wet dock, which will be available for their ironclads. All along the shore there are large stores where grain is received from the interior; they are specially built, and have all modern facilities for careful storage and despatch in shipping. The ships loading are anchored in lines in the bay, at safe distances from each other, and the grain, so soon as bagged, is carried on men's shoulders to the beach, and there put into lighters carrying from eleven to eighteen tons each. During the summer months quick despatch is given to sailing vessels, but during the months of May, June, and July, owing to the prevalence of northerly winds and rain, detention is sometimes very serious.

Tomé is another grain-shipping port, much smaller than Talcahuano, and situated at the south side of the bay; these two ports, and the town of Concepcion, are full of commercial activity. Germans again predominate. They own flour mills, breweries, tanneries, soap factories, cloth factories, carriage works, a sugar refinery, and a number of other industrial establishments which are all in healthy working order, and leaving excellent returns on the capital invested.

Train was taken at Talcahuano, and ample time was given by us, on the route inland to Concepcion, San Carlos, Chillan, Parral, Linares, Talca, Curico, on to Santiago.

The whole line of railway may be put down as through one vast plain, almost all under cultivation, and intersected with rivers. Every point was seen to advantage, our journey being during harvest season.

Santiago.

Santiago, the capital of Chile, is a large and very fine city, and has a population of 190,000 inhabitants. It stands in a beautiful valley, entirely surrounded by the Cordilleras de los Andes, with their perpetually snow-clad heights. You can stand on the Campo de Marte, a large plain just outside the city, where all the military exercises take place, and where a good view can be obtained of the mountains, and you see no outlet. The city is quite mountain-locked, if I may coin such a term. It is well laid out in blocks, the streets running parallel to each other, and crossing at right angles. Throughout the city you find many splendid buildings, with imposing stuccoed fronts. These are the residences of the wealthy owners of estates, mines, &c., and are mostly built and furnished regardless of cost. The style is becoming more and more European, as far as the climate will allow. The interiors are still, however, on the old Moorish plan—that is to say, the rooms are built round large courts, in which flowers bloom and fountains play. Camellias are often seen, and attain to the size of trees, and palms and other plants, which in this country are grown under glass, blossom freely in the open air, such as pelargoniums, fuschias, lemon-scented verbenas, lilies, &c., &c. While on this subject I may mention that the creeper "Lapageria," which here requires the shelter of a hot-house, grows wild in the south of Chile, and that in the forests of the province of Valdivia it hangs in profusion in the full glory of its crimson, waxy bells. White and pink are also seen, but these are rarer. In the south also grow the Araucarias, trees which we know well here. Dense forests of these are to be seen, and there the peculiar manner in which they shed their lower branches is observable. They seem to require light and air all round, and when growing in their wild state you can often see large numbers of them with bare stems for a height of thirty to forty feet, the branches spreading out above this. But we must return to Santiago.

Through the city runs a long avenue for promenading purposes, called the Alameda, or Cañada, an indispensable feature of all Spanish towns. This walk is bordered with rows of trees—poplars, acacias of different sorts, and others. These acacias flower in summer, loading the evening air with perfume. The Alameda is ornamented with statues of celebrated patriots, and gardens, and is nearly five miles long. One portion is kept in exquisite order, swept and watered daily, and it is here that the *elite* of Santiago come in the late afternoons for their daily promenade. Their equipages are perfectly appointed with good horses. No finer turn-out of carriages can be seen in Hydepark, if it can even be equalled. The Chilian ladies dress gaily, and hence the scene in the Alameda is a brilliant one. In the summer months of January and February the heat is intense in the day-time, but the mornings and evenings are cool. This city is the seat of Government. The House of Congress is a very fine building, and has two Chambers, one for Deputies and the other for Senators. The President is elected for five years, and he cannot be re-elected twice consecutively. Roman Catholicism is the religion of the country, though religious toleration is now granted by the Constitution.

Santiago possesses a university, numerous churches, schools, convents, a cathedral, an archiepiscopal palace, a fine market-place, and many specimens of old Spanish doorways. It is within a day's journey of the mineral baths of Cauquenes and Apoquindo, the former of which is situated high amongst the mountains, and where a most agreeable fortnight may be spent in admiration of the grandeur of the everlasting hills, and the river with its impetuous rush of water and volume of sound as it brings down rocks and stone in its rapid course.

Santiago is a thoroughly aristocratic city: business is conducted quietly; no sense of hurry profanes its quiet streets, but a serene calm pervades the whole. This is a decided contrast to busy Valparaiso, its seaport, to which I now ask you to accompany me by rail.

Valparaiso.

There are two passenger trains daily. The earlier is the one to be preferred during the whole of the year, and even in the hottest months, as the journey for three-fourths of its length is over before the heat is much felt, and just as it becomes almost too intense the cooling breezes from the sea are experienced, and all goes well. The run down is glorious for scenery of every description. Immediately on leaving Santiago a splendid view is obtained of the grand valley in which it stands, and for about an hour the view is uninterrupted. There are the fields under cultivation, the Cordilleras with their snow-capped peaks, and the city dotted with its many spires—all under the brightest of skies and with the clearest of air. During the journey we cross the famous curved bridge, called "Maquis," which when built about twenty-seven years ago called forth the attention of all the railway engineers in the world, owing to the boldness of the idea involved in its design. The bridge crosses the deepest ravine in the country.

The line of railway is in some parts exceedingly tortuous, and the gradients are extra steep, but soon after crossing Maquis Bridge comparatively level ground follows, and soon we run into the beautiful and fertile valley of Quillota. The line from Quillota is almost through one immense garden, the pleasant villages or towns of Limache, Quilpué, El Salto, Viña del Mar, being all favourite summer resorts. In Vina del Mar there is the sugar refinery of Mr. Bernstein, complete in every detail, with the very latest improvements. It covers eight acres, and has within the grounds a gasworks, a cooperage, and a distillery. This refinery employs about 1,000 to 1,500 men, and turns out daily from 50 to 80 tons of sugar. The raw cane sugar is imported from Peru and Java. Very shortly the train enters the port of Valparaiso. Between Talcahuano and Valparaiso, on the coast, there are the small grain ports of Constitucion, Llico, San Antonio, &c., from which wheat and flour, as also barley and other articles of produce, are shipped in fair quantities.

With a few figures giving the exports from the south, we may be said to have finished the agricultural portion of Chile.

The finest quality of wheat is to be found inland from Valparaiso, in particular around Parral, Chillan, and San Carlos, as also at San Antonio, and in the valleys more to the south and very near to Talcahuano. In the vicinity of Santiago and Talca, there are a number of flour mills, fitted with the most modern machinery. The owners of these purchase all the finest wheat. The total output of all the flour mills is close on 160,000 tons, of which 140,000 tons are consumed in Chile, and about 20,000 tons are exported to England and other countries. The total export returns for wheat, barley, and flour, for two years, are:—

	1886.			1887.		
Wheat,	120,000 tons,	value	£800,000	124,000 tons,	value	£950,000
Barley,	9,000 ,,	,,	60,000	4,000 ,,	,,	30,000
Flour,	7,000 ,,	,,	70,000	3,000 ,,	,,	30,000

The returns for 1888 will give a total export of wheat and barley more or less 15 per cent. increase.

Chile is divided into two distinct portions, the upper or northern which is entirely mineral, and the lower or southern which is agricultural. The rainfall in the north is *nil*, we may say, but gradually it increases towards the south, and in the southernmost regions it is very heavy, being equal to 40 inches per annum.

The vegetation of the south is almost tropical in its luxuriance, and naturally the opposite is the case in the north, where grass is unknown, and where there are persons who do not know what a tree is.

Valparaiso, which has a population of about 110,000, is the principal seaport. It stands about midway between north and south, where the rainfall is moderate for five months in the year, being about 18 to 22 inches, while for the other months good weather is the rule. The heat is not so intense as at Santiago, and the mornings and evenings are always pleasantly tempered by the sea breezes. Strong south winds blow severely during the summer, bringing sand and earth down from the hills, often so abundantly that the very water in the bay is discoloured for a considerable distance. This city derives its name from the pleasure experienced by the Spaniards, who, after their conquest of Peru, came southwards, traversing the desert of Atacama, and the mountains and plains of Chile, until they reached this place, where they found grass and water, palms and vegetation (which have now disappeared to make way for buildings), and rest for their wearied selves. These, therefore, named it Valparaiso, or the Vale of Paradise. The town is built on a narrow strip of land at the foot of some hills, which form a sort of amphitheatre. A great part of it has been reclaimed from the sea, and where thirty years ago one of the hills could only be rounded at low tide, three broad streets and a good esplanade now run between hill and sea. The foreign residents are so numerous as to have given it a character distinct from that of any other town in Chile, while its commercial activity out-distances that of all others. The foreigners mostly reside on the hills that surround the town, these being the healthiest and most pleasant parts, and from which the view of the bay is grand, with the snow-clad peak of the volcano Aconcagua as a background.

Valparaiso is the grand centre between south and north; to it the coast steamers, which are called feeders, bring from the south flour, barley, wheat, cattle, &c., &c., for transhipment to the regular traders for the north. The north is entirely dependent on Valparaiso and the south for almost everything that it consumes. Good progress has been made during the last five years in increasing the discharging facilities of the port by the construction of a large pier built of iron and close to the Government Custom-House stores. Alongside of this pier the large steamers are placed, and the discharge of the bulk of the finer portion of their cargoes takes place very quickly. The goods are landed on small waggons which are run on lines of rails to the particular section for which they are intended, where they are at once hoisted by a hydraulic lift to their special flat. The discharging facilities, however, are not equal to the requirements, as the 11 20 ton launches sent alongside the vessels at anchor in the bay rarely manage to make over two trips each, the total summing up say 60 to 70 tons from each ship per day. The forwarding facilities are excellent. As the Santiago railway line is extended to right alongside the Custom-House stores, cars or waggons are conveniently placed, and then loaded for all parts of the interior. The Government Customs stores are solid, handsome blocks, and the immense amount of work connected with the receiving and delivering of goods for the supply of almost the entire Republic, and also part of Bolivia and Peru, is done in a most expeditious and creditable manner. For the repairs of steamers and ships there are two wet docks belonging to a limited liability company.

The port is now thoroughly well fortified by fourteen forts commanding the entrance from every possible point, and all constructed under the most modern ideas, with Armstrong guns and others of the Blakely, Parrott, and other types. With one exception, all these forts were constructed by native engineers; and experienced officers from other countries who have visited them have expressed themselves surprised at the careful way in which they have been finished.

There is good anchorage in the bay, but frequently during the winter months of May, June, July, and August there are strong northerly winds from which there is no protection, and during that period all operations connected with ships are suspended.

Forming part of Valparaiso, there is eastwards the Almendral, a low-lying district nearly all reclaimed from the sea. This district is almost entirely taken up with the dwelling-houses of the natives, and the principal street, called Victoria, is one of the most attractive to be seen anywhere. In breadth it is greater than Buchanan Street, and what with its broad pavement, its rows of trees on both sides, coupled with the picturesque appearance of the many-coloured buildings and their different styles of architecture, it is certainly one of the finest streets in Valparaiso.

COQUIMBO AND THE MINING INDUSTRY.

We will now proceed to Coquimbo (population 7,000), an important copper-shipping port, about twenty hours' steaming from Valparaiso. Here there is an excellent bay, and the amount of work done daily in loading and discharging proves that in the attractive and apparently quiet-looking town there is a very great amount of mining work going on. The port and neighbouring town of La Serena are dependent on the produce of the various mines which are being worked, and nearly all the inhabitants are engaged in, or are in some way connected with, mining. The mining district of La Higuera is an important one, and for it there is a magnificent future.

Close to Coquimbo we have the small port of Totoralillo, where there are three or four smelting works of considerable importance. Also close to Coquimbo we have the very small bay of Herradura, where are to be found the copper mines of the Panulcillo Copper

Company and others. There are no better equipped smelting works on the coast, and the statistics prove the steady, constant work which is being carried on.

The remaining copper ports of Chile are those of Huasco, Carrizal, Caldera, and Chañaral.

Owing to the extraordinary low prices which ruled during [illegible]-86-87, a severe check was given to copper mining; the greater number of the small mines had to be stopped, while the output of the more important had to be reduced, the exports falling from [illegible] tons to [illegible] tons. The attention of nearly all the miners was turned to the abandoned silver and gold mines, but no sooner had copper prices again reached a remunerative figure, than work was at once resumed, with the result that copper mining to-day in Chile is being more enthusiastically pushed than it has ever yet been, and the total exports of 1888 will be close on [illegible] tons, or [illegible] per cent. over those of 1887. Since the advance in price of copper, and particularly in view of the formation of contracts made by the Copper Syndicate, the attention of miners has been given to other districts, and, according to latest accounts, we are likely to have a fair increase from the Tarapaca province, a district only known up to date in connection with the important article of nitrate of soda. The copper deposits of the Tarapaca districts are allowed by experts to be rich, and it is purely a thing of time till we find the exports of bar copper from Iquique comparing well with those of the ports to the south. Large smelting works are being put up at the rich mining district near to Iquique. This mineral district, Mocha, is a mining centre of great importance. It is situated about [illegible] miles inland from Iquique, on the lateral spur of the chain of hills which spring from the central Cordillera.

The Spaniards had a mania for mining, and a considerable number of the Chilians have inherited it, and all over the north coast, as also inland, there are innumerable abandoned mines waiting for enterprise and capital to re-open, and which in almost every instance, giving due time for development, would leave handsome returns. Deposits of manganese are found inland near to Peumo, on the southern railway, but, owing to cost of carriage and the price ruling on this side, much life has not been put into the industry in that district. From Coquimbo and Huasco fair exports have taken place, and we feel that there is an immense business to be done in the article, which at all times will, however, be in sympathy with the prices ruling on this side. The manganese ore industry only dates from 1884.

Silver mining has undergone a great development in Chile during the last few years, principally owing to the unprofitable price which ruled for copper, as also to new deposits being discovered, and refining being better understood. Gold, for the same reasons, has also lately been worked, in very paying quantities, in the north, and is attracting a large amount of attention. Poor and rich veins of both of these metals are to be found all over the Republic, certainly to a much greater extent over the north than the south.

The richest mines are those near to Copiapo, Antofagasta, and Iquique, and from the statistics which we have prepared the output proves conclusively that, like as with coal, copper, and manganese, Chile offers fields of wealth which only await energy, push, and capital. In the province of Tarapacá there have recently been re-opened silver mines which for many years had been abandoned, giving to the new owners simply fabulous returns.

BAR COPPER EXPORTS.

	Average Price per Ton.			Average Price per Ton.	
1878,	£61 16s.,	40,000 Tons.	1884,	£57 4s.,	35,000 Tons.
1879,	£58 4s.,	38,000 ,,	1885,	£43 18s.,	35,000 ,,
1880,	£62 17s.,	32,000 ,,	1886,	£40 9s.,	34,000 ,,
1881,	£61 14s.,	32,000 ,,	1887,	£41 17s.,	26,000 ,,
1882,	£67 6s.,	36,000 ,,	1888, For four months (Jan., Feb., Mar., Apr.),	£79 8s.,	12,000 ,,
1883,	£63 4s.,	36,000 ,,			

	1887. Tons.	1888. Tons.	Total. Tons.
Caldera,	660	2,714	3,374
Coquimbo,	4,126	5,396	9,522
Valparaiso,	848	1,095	1,943
Coronel,	3,201	2,829	6,030
	8,835	12,034	

3,000 Tons increase for four months, 1888, over same four months, 1887.

SILVER EXPORTS.

	Average Price per Ounce (Troy).	Ounces (Troy).		Average Price per Ounce (Troy).	Ounces (Troy).
1878,	52⅓ Pence,	1,430,254	1883,	50½ Pence,	2,665,326
1879,	51⅓ ,,	2,092,220	1884,	50⅔ ,,	2,310,240
1880,	52¼ ,,	2,929,584	1885,	48⅔ ,,	5,408,988
1881,	51¾ ,,	1,305,531	1886,	45¼ ,,	5,371,760
1882,	52 ,,	3,358,766	1887,	44 5/16 ,,	6,733,992

NITRATE OF SODA.

Without troubling you with all the details as to the position of Peru, Bolivia, and Chile previous to the late war, I would just remark that "Nitrate," a question of the export duty, was the cause. Up to that time Peru had under her control all the nitrate works of importance, excepting a most extensive one at Antofagasta, erected under special agreement with the Government of Bolivia and Chile, and two or three small deposits in Chile. The result of the war of 1879-80 gave Chile entire control over all the nitrate deposits on the coast, and it is only since the war that private enterprise has been able to develop the great industry in nitrate of soda.

Iquique and Pisagua are the principal nitrate ports on the coast. Iquique is built on a sandy plain, at the foot of hills which are about 3,000 feet high. The population is about 17,000, foreigners forming about 35 per cent. of the whole. The town is dependent for supplies of every kind from outside, even to water, the greater part of which for domestic and other purposes is still being brought in the holds of specially-built steamers from the neighbouring port of Arica; but the successful floating in London (not in Glasgow, where it was first offered) of the Iquique Water Company will soon put the town as regards water on a par with Glasgow. The nitrate deposits are on the plains or Pampas 3,000 to 4,000 feet above the level of the sea. From statistics we find that the first shipments were made about 1830 of 900 tons; then from 1830 to 1840, 5,000 tons; 1840 to 1850, 30,000 tons; then from 1850 to 1860, 60,000 tons; 1860 to 1869, 200,000 tons; then from 1870 to 1878, 350,000 tons per annum. These details show the steady onward progress made in the manufacture and shipment of the article from the first trial lot in 1830 to 1878. Appreciation of the value of nitrate by farmers and others all over the world became marked; but it was found necessary to determine and set at rest the questions regarding the virtues procured through nitrate, many persons affirming that it exhausted the soil, gave a splendid crop in the first year, but required more next, and so on in successive years.

Professor Paul Wagner, Director of the Agricultural Research Station, Darmstadt, and the recognised authority on agricultural chemistry in Germany, set himself to work to answer the question, "Does the application of nitrogenous manure produce an increased yield of all field crops?"—and in his report on the subject he gives a mass of information, showing the increased yields of various crops, obtained by the application of 100 lbs. of nitrate per acre, calculated at from 9s. to 11s. 6d., as also the quantities of nitrate which can be profitably used for different classes of produce. He then very strongly recommends farmers to apply nitrate in every kind of cultivation. The fame or value of nitrate as a fertiliser became more and more wide-spread, and the exportation under Chilian protection has taken, and is taking, majestic strides.

In 1884 a combination was formed, which lasted till 1887, restricting the shipment of each "oficina," or nitrate works, in order that prices should be maintained, by simply producing an amount equal to the demand. Under the combination the shipments in 1885 were 430,000 tons, in 1886 435,000 tons, but for many reasons the combination was cancelled, and we find 1887 giving 700,000 tons, and 1888 will approach, if not exceed, 800,000 tons. Scotch ports during 1888 have taken in all 26,500 tons, about 6,500 tons over the imports in 1887. The United Kingdom has taken 103,000 tons, which is also an improvement on 1887. The Continental ports have absorbed 550,000 tons, being 150,000 tons over the imports in 1887. These figures conclusively prove the correctness of Professor Wagner's conclusions, and that the demand will go on increasing is simply beyond any doubt.

With these particulars we now return to the province of Tarapacá, and in particular to the nitrate deposits. These deposits are about 150 miles in length and about 50 in breadth, and as the ports of Iquique and Pisagua, as also all the nitrate companies, are dependent on the extent of those nitrate deposits, the question of duration was and is the all-important one. Without entering into any of the many important details, suffice it for me to state that in Germany and England competent persons are agreed that almost over the entire extent nitrate exists to an average depth of 3 to 5 feet, and that on a basis of shipments for 1888, of 800,000 tons, it will be well nigh on to fifty years before the deposits begin to give out. Iquique and Pisagua, therefore, as ports, have their future guaranteed. Chile, at present with an income from nitrate alone of £1,800,000 to £2,000,000, and with an increased demand at the same duty of 2s. 6d. per quintal of 100 lbs., or £2 12s. 6d. per ton, has a most solid future in that respect.

Raw nitrate of soda, or, as it is called çaliche, is a mineral deposit, invariably found in beds 2,000 to 3,000 feet above the level of the sea, and at distances from the sea of about 30 to 100 miles. It is met with in the thickest layers and of the best quality on the sides of the basins, which at one time must have been small lakes. Mr. Darwin describes the appearance of the desert of Tarapacá as resembling that of a country after snow, before the last dirty patches had thawed, the whole being covered by a thick crust of salt, and of a stratified saliferous alluvium, which seems to have been deposited as the land slowly rose above the level of the sea. The existence of this crust of soluble substance over the country shows how extraordinarily dry the climate must have been for a long period. These crusts, as we have already remarked, are from 3 to 5 feet in depth, occasionally being found up to 12 feet, and in their rough state generally give 50 per cent. of nitrate of soda, 25 per cent. chloride of sodium, 5 per cent. of sulphate of soda, 4 per cent. of sulphate of magnesia, the balance insoluble matter. All the nitrate works have good machinery, part of which is made at Iquique and Valparaiso, but the bulk is imported from England and Scotland, and embodies all modern improvements. The margin of net clear gain, put on board of the launches, ready for shipment, runs from 30s. to 50s. per English ton, according to the machinery used and the distance from port. Taking it to be 30s., we have a total profit on the output of 1888 (800,000 tons) of £1,200,000.

Till quite recently the production of nitrate was confined to the works of Messrs. Gibbs & Co., Hainsworth, Watson, & Co., Gildermeister & Co., and a few others. With a continuation of the appreciation to date, there is ample room for all the "oficinas" floated, and if nitrate deposits can be discovered at or near other workable ports, also for a considerable addition to their number. Shipowners representing the 1,500,000 tons of carrying capacity required by Chile yearly for her ports, particularly the nitrate ports, will be pleased to learn that their one complaint against the coast—namely, detention, will soon disappear, as Government are at present engaged arranging for the construction of piers at Pisagua and Iquique, and some of the other important ports.

NITRATE EXPORTS.

	Tons.		Tons.
1879,	58,410	1884,	550,833
1880,	222,530	1885,	422,896
1881,	352,466	1886,	445,658
1882,	481,640	1887,	701,543
1883,	575,590		

NITRATE PORTS—EXPORTS FOR 1886 AND 1887.

	1886. Tons.	1887. Tons.
Pisagua,	133,300	268,375
Iquique,	231,693	363,976
Tocopilla,	7,600	8,865
Antofagasta,	25,815	27,674
Taltal,	47,250	32,653
	445,658	701,543

INCREASE IN NITRATE AND OTHER EXPORTS.

Goods.	1886.	1887.	Increase.
Nitrate,	£3,205,000	£4,781,000	£1,576,000
Silver,	1,094,000	1,382,000	288,000
Gold,	2,950	191,480	188,530
Wheat,	815,000	944,000	129,000
Manganese,	40,000	79,000	39,000
Borax,	38,000	76,000	38,000
Copper,	46,000	79,000	33,000
Skins,	40,000	70,000	30,000
Gold Bars,	32,000	61,000	29,000
Coal,	130,000	153,000	23,000
Lime,	2,000	12,000	10,000
Copper,	2,000	5,000	3,000
Nueces,	32,000	34,000	2,000
Dry Straw,	6,000	7,000	1,000

RAILWAYS.

I will now ask your attention to the long map, which I have had specially prepared. The railways in actual working order are marked in "dot-and-dash" lines, and those in course of construction are shown by dotted lines. These railways are nearly all Government property, and on the average pay well. The lines have tapped some of the principal centres, and like many other undertakings it is a thing of time till their facilities are properly understood, and then the returns will, after paying interest, materially assist Government in their ideas for the advance of every town in the Republic. The Government have just contracted for ten new lines at a cost of £3,542,000. Tenders were asked from England, Scotland, France, Germany, and the United States, according to plans and specifications. Ample time was given, and, after due consideration, the North and South American Construction Company carried off the whole contract.

Four of these new lines are to be completed within two years, five in three years, and the tenth in five years.

At one stage it was intended to borrow the total money required for the construction of the ten lines, but the different periods fixed for their completion have been so arranged as to enable Government to pay the entire sum without assistance from any quarter. In five years' time Chile will have railway communication with all her towns. These lines, as you will note, run among the mining section, north and south; they will open up thoroughly and enliven that portion of the country which the Government are desirous of seeing filled with agriculturists. Long before the end of these five years, it is almost beyond a doubt—and I heartily wish the idea all success—that Messrs. Clark's enterprise will be completed, namely, uniting Valparaiso with Buenos Ayres by rail. John and Matthew Clark have, with the patience and intelligence which have distinguished them during the last fifteen years, made steady progress with their lines; and as they have completed the full connection between Buenos Ayres and Mendoza on the eastern slope of the Andes, and while from Valparaiso to Santa Rosa on the western foot of the Andes it is already open, we do not think that it is too much to state that the remaining 100 miles, that is to say, between Mendoza and Santa Rosa, will be completed during the next two or three years. For your guidance the distance will be—

Buenos Ayres	to Mendoza,	646 miles.
Mendoza	,, Santa Rosa,	152 ,,
Santa Rosa	,, Valparaiso,	82 ,,

When this line is opened it cannot but do good; the first good will be the bringing of Chile ten to twelve days nearer England. Instead of, as at present, occupying twelve to fourteen days between Monte Video and Valparaiso, passengers will land at Buenos Ayres, and reach Valparaiso within thirty-six hours. Fine goods, and all articles which can afford to pay the extra freight, and which are required to catch a market, will also be forwarded; and, in a word, the whole of the present means of transit will be reformed, and cannot but do good to the Argentine, Uruguay, and Chilian Republics. Then, to conclude with railways, most likely with a continuation of goodwill amongst the Republics, there will be seen before the end of the nineteenth century a line of railway of about 2,500 miles in length, or, say, from Buenos Ayres through Chile, Bolivia, on to Lima, the capital of Peru.

Navy of the Republic.

The navy of Chile consists (1) of two ironclads, carrying six Armstrong's Nordenfeldts, both fitted with twin screws; (2) two cruisers, one of them being the famous "Esmeralda," built since the war five years ago (it was then the quickest afloat, doing easily twenty-two knots an hour); (3) three corvettes of about 1,600 tons each, well equipped; (4) two gunboats, one being the now famous "Huascar," which before and after the war came so prominently before the world; and (5) ten torpedo boats of latest construction. In addition to these, there will be added soon two more vessels approaching the cruiser type, two more ironclads, and two cruisers. The mercantile marine under the Chilian flags consists of 38 steamers = 20,000 tons; 89 barques = 43,000 tons; 8 full-rigged ships = 10,000 tons; 11 brigs = 3,000 tons; smaller vessels about 3,000 tons; giving a total of 177 vessels, aggregating about 80,000 tons.

CONCLUSION.

In a few concluding remarks I may add that, with exports increasing at each of her ports, engaged as she is in revising and reforming laws connected with her mines and taxes, and opening up new districts of her country, Chile is not overlooking any one detail of the many points which in a marked degree assist in bringing about the sound position which she enjoys.

The religion of the country, as I have already remarked, is Roman Catholic, not in an extreme sense, but in a broad manner —the priests having for some time had no power. Foreigners have full religious liberty. Then, in connection with education, Government take under their special charge the National Institution with its 6,000 students, the School of Medicine, the Military and Naval Schools, the different Agricultural Schools situated over the south, and the School of Arts and Trades for Women. I may here say that in about six months another such establishment will be finished for men. The National Schools are deserving of special remark. There are in all about 1,100 of them, representing nearly 90,000 scholars, giving an average attendance of say 70,000. These 1,100 will be augmented by 208 more, to hold in all 130,000 children, 42 having just been finished, 58 to be ready in six months, 58 by the end of this year, and other 50 during 1890.

Chile has never countenanced the importation of slaves, and she has always resisted attempts at Chinese or Coolie immigration.

The nature of the soil demands constant attention, hence we find of the entire population of 2,700,000, there are 550,000 engaged at the mines, nitrate, and other works in the north, while 160,000 are spread over the wooded districts from Lebu to the

Straits, and 1,500,000 are engaged in agricultural pursuits, the remainder, say 500,000 or 600,000 representing the towns.

With such an industrial population, with such undeveloped resources north and south, with intelligent and travelled administrators, who have always at heart a love for progress and justice —even without the introduction of more capital, her march in the future cannot but be progressive. Her character and her appreciation of, and fostering care for, all that is good, combined with her climate, call for, on this side, a serious study of each of the points that I have touched on; and with the introduction of more capital, accompanied with the necessary talent for its expenditure, I think I may safely say her future prospects are satisfactory in the highest degree.

SUPPLEMENTARY TABLES.

1.—Imports and Exports.

Imports.	Exports.	Total, 1886.
$44,200,000 = £7,400,000	$51,240,149 = £8,500,000	$95,500,000 = £15,900,000

Imports.	Exports.	Total, 1887.
$48,700,000 = £8,120,000	$60,000,000 = £10,000,000	$108,700,000 = £18,120,000

Or, say, $13,000,000 = £2,200,000 increase.

Imports, $4,500,000 = £750,000
Exports, $8,500,000 = £1,450,000 } = $13,000,000 = £2,200,000.

2.—Value of Imports and Exports in each Port.

1886.

Ports.	Imports.	Exports.	Total.
Valparaiso,	£6,000,000	£2,300,000	£8,300,000
Iquique,	300,000	2,300,000	2,600,000
Pisagua,	60,000	1,000,000	1,060,000
Talcahuano,	370,000	654,000	1,024,000
Coquimbo,	300,000	700,000	1,000,000
Coronel,	40,000	600,000	640,000
Taltal,	36,000	340,000	376,000
Caldera,	90,000	260,000	350,000
Antofagasta,	74,000	260,000	334,000
Tocopilla,	20,000	122,000	142,000
Carrizal B.,	70,000	20,000	90,000
Valdivia,	40,000	7,400	47,400
Ancud,	900	2,000	2,900
Mellipulli,	1,300	3,000	4,700
	£7,400,000	£8,500,060	£15,900,000

1887.

Ports.	Imports.	Exports.	Total.
Valparaiso,	£6,140,000	£2,200,000	£8,340,000
Iquique,	600,000	2,700,000	3,300,000
Pisagua,	30,000	2,000,000	2,030,000
Talcahuano,	540,000	840,000	1,380,000
Coquimbo,	320,000	700,000	1,020,000
Coronel,	84,000	600,000	684,000
Taltal,	64,000	410,000	474,000
Caldera,	133,000	170,000	303,000
Antofagasta,	100,000	200,000	300,000
Tocopilla,	7,000	115,000	122,000
Carrizal B.,	41,000	42,000	83,000
Valdivia,	60,000	25,000	85,000
Ancud,	3,000	7,000	10,000
Mellipulli,	1,000	5,000	6,000
	£8,120,000	£10,000,000	£18,120,000

3.—INCOME.

		1886.	1887.	1886.	1887.
Custom-Houses,	Nitrate,	£1,420,000	£2,200,000	£3,900,000	£5,000,000
	Yodo,	27,500	11,000		
	Others,	2,420,000	2,750,000		
Guano,				45,000	29,000
Railways,				1,070,000	1,050,000
Post-Offices and Telegraph,				92,000	100,000
Mint,				25,000	70,000
Other sources,				1,170,000	1,400,000
				£6,200,000	£7,700,000

Or, in favour of 1887, say £1,500,000.

In addition to which they netted $22,260,000, result of the conversion of the Debt and Nitrate Certificates,	3,710,000
	£11,410,000

4.—DEBT.

Foreign,	$40,000,000 = £6,700,000	$88,000,000 = £14,700,000
Internal,	$48,000,000 = £8,000,000	
Paper money in circulation,		$25,000,000 = £4,200,000
which is being *monthly* reduced by the incineration of		$100,000 = £17,000

so that, at the present rate, in 25 years there will be none in circulation.

XXIII.—*An Examination of the Report of the Royal Commission on the Recent Changes in the Relative Values of Gold and Silver, with remarks on Bi-metallism.* By Charles Gairdner.

[Read before the Economic Science Section, 19th February, 1889.]

Two years ago, in a paper read before this Section, I reviewed the Report by the Royal Commission of 1885 on the Depression of Trade. I now propose to continue the subject by examining the Report of the Commission which followed upon the first, and to consider the recommendations which it contains.

Let me, in the first place, remind you of the point at which we were left by the earlier Commission. The view taken of the Depression of Trade by the first Royal Commissioners, was that it proceeded from "a diminution and, in some cases, an absence of profit, with a corresponding diminution of employment for the labouring classes." But when they came to examine into the causes of this absence of profit and diminished employment, the Commissioners had to admit that there was no diminution whatever *in the aggregate* wealth of the nation, or in the volume of its trade. On the contrary, they asserted* that the general production of wealth in the country had continuously increased though its distribution had undergone great changes, with the result that a larger share than formerly had passed to the consumer and the labourer, and a more equal distribution of wealth had thus been promoted. They also recognised that there is now greater competition than formerly with foreign nations, and that there is, therefore, need for increased vigilance, for greater activity in the search for new markets, for improved technical education, and for attention to sundry other matters of minor importance, relating chiefly to the transit of merchandise and the like; it being expressly pointed out that the great object to be aimed at was the "cheapening of the cost of production."† The Commissioners admitted that as the result of their inquiries they had "few recommendations to make,"

* Final Report of Royal Commission on Depression of Trade, s. 92.

† *Ibid.*, s. 94.

and the final conclusion at which they arrived was "that while, on the one hand, the information they had been able to collect will tend to dispel much of the misapprehension which appears to prevail on the subject of our commercial position, and to encourage a more hopeful view of the situation; it will also show that if our position is to be maintained it must be by the exercise of the same energy, perseverance, self-restraint, and readiness of resource, by which it was originally created." *

It will thus be seen that the practical outcome of the first Royal Commission was to discourage the expectation that the so-called "Depression of Trade" could be ameliorated by legislation. But, while this was so, the Commissioners pointed out that the evidence before them had shown that the depression was not confined to this country, and that the changes in the value of the precious metals, as affecting the currency of the commercial nations, had, in the opinion of some of the witnesses examined, a peculiar bearing upon trade and industry, and upon the price of commodities. They, therefore, strongly recommended that this question should receive "early and separate examination from other points of view than that of their Commission, and that, apart from its general connection with the depression of trade, it should be treated with reference to our Currency as a whole, and to our monetary system at home, and to its relation to our Colonies, to India, and to foreign countries.

The recommendation thus made led to the appointment of the second Royal Commission, the members of which were enjoined to investigate—

(1) The cause of recent changes in the relative values of the precious metals:

(2) The bearing of such changes on the Government of India; on the interests of persons resident there; on the producers, merchants, and tax-payers there; and on the merchants and manufacturers at home who trade with India:

(3) The bearing of such changes on the Trade of the United Kingdom with silver-using countries other than India; on our foreign trade generally; and on our internal trade and industry.

In the event of the Commissioners coming to the conclusion that the changes referred to were the cause of permanent and important evils or inconveniences to the interests above referred to, they were

* Final Report of Royal Commission on Depression of Trade, s. 106.

to report on the remedies, if any, within the power of the Legislature or Government, by itself or in concert with other powers, by means of which such evils might be removed or palliated.

This being the general purpose and scope of the Commission, much evidence has been taken which has been summarised in the First Part of the Report. To this part all of the twelve Commissioners are signatories, and as they were from the first equally divided in their general views of the questions remitted to them, they have drawn up this First Part in the form of statement and counter-statement, argument and counter-argument, following one another in rapid and somewhat bewildering succession; so that it is not surprising to find the Commissioners unanimously confessing that from the commencement of the inquiry they had been "profoundly impressed with the extreme complexity of the questions submitted for their consideration."* In the Second and Third Parts of the Report, each signed by six members, and in the Notes appended to them, we get to know more clearly the opinions of the Commissioners, the grounds on which they rest them, and likewise the remedies which they recommend.

In now attempting to bring before you, within the brief space of time at my command, the more salient points of the Report, I do not intend to present any analysis of the evidence. It is extremely conflicting, and is occupied to a large extent with matters not of fact but of opinion. It is necessary, therefore, that it be considered with reference to the knowledge, capacity, and experience of the various witnesses, and, because of this, every one who would form an independent judgment must read and digest it for himself. I think that for this reason, and also because of the very involved nature of the subject, I shall best be of service to you, as practical men, by going at once to the evils and inconveniences complained of, and to the recommendations made for their amelioration.

We find, then, that the only evils and inconveniences which the Commissioners have unanimously agreed to regard as proved are†—

First, The inconvenience and burden to which the commerce is subject, between countries using gold and silver, owing to the fluctuations in the relative value of these metals; and,

* Final Report on Gold and Silver, Part I., s. 5.

† Report on Gold and Silver, Part II., s. 106.

Second, The difficulties in which the Indian Government is involved, owing, not only to the fluctuations in the relative value of the metals forming the standard in this country and in the Indian Empire respectively, but also to the fall which has taken place in the gold price of silver, as well as the uncertainty and apprehension due to the impossibility of forecasting the future position of that metal, and the extent to which its gold price may yet fall.

As regards the first of these inconveniences, it is only necessary for me to say, before an audience such as this, that fluctuations of the kind referred to belong to the ordinary common-place experience of merchants. They form, no doubt, a troublesome incident in commerce; but one which is perfectly well understood; and now that the great centres of wealth and population are connected by the telegraph it has even less importance than it formerly possessed. I do not think I should be justified, therefore, in taking up your time with any remarks explanatory of this subject.

As regards the second, the case is different. An actual fall of 25 to 30 per cent. in the value in gold of the standard metal of India, and the uncertainty that attends the future, are matters of serious moment to the Government of India, and have naturally created much anxiety. It is easy, however, to exaggerate; and it will, therefore, be well to endeavour to reduce to figures the measure of their importance.

The case of the Government of India has been forcibly put in a despatch addressed by the Viceroy and other high officials to the Secretary of State for India, of date 4th September, 1886. From it, from the financial accounts submitted annually to Parliament, and from other authentic documents, the following facts have been taken for the purpose of arriving approximately at the extent, as well as the nature, of the evil complained of—that evil being the loss occasioned to the Indian Exchequer from a certain portion of the disbursements being made in England in gold, while the revenue is received in silver. Taking the figures of the last three years, the following summary shows the net expenditure of the Indian Government in England, and the loss on exchange charged on the Indian revenues of these years:—

	1886-7.	1887-8.	1888-9.
Sterling,	£14,172,208	£15,216,200	£15,028,700
Exchange,	* Rx. 5,329,712	Rx. 6,390,800	Rx. 6,312,100

* Rx. means tens of Rupees.

If the gold value of the rupee should continue to fall, every drop of one penny per rupee would, upon £15,000,000, be equal to about Rx. 1,000,000 of additional exchange.

The particular items which make up the sum of the expenditure in England, and create the necessity for these sterling remittances, may be conveniently grouped thus. I take the figures of 1888-89:—

Interest and Management of Debt, excluding Railways, -	£2,620,800
Railway Revenue Account, - - - - - -	5,615,300
Civil Administration, - - - - -	220,900
India Office, - - - - - - -	199,200
Army effective—Home Charges of British Forces in India, Transports, &c., - - - - -	953,200
Stores, - - - - - - - -	1,327,400
Furlough, - - - - - - - -	559,000
Non-effective Charges, - - - - - -	3,532,900
	£15,028,700

The Indian Government complain, then, of the provision for exchange of Rx. 6,000,000, more or less, required from their revenues, in order to their meeting engagements to the above amount in England; and they also complain of the great uncertainty which is introduced into their estimates because of the fluctuations in the rate of exchange. In the despatch just referred to, the position is declared to be "intolerable," and what is stated to be "essential in the interest of the finances of British India is the establishment of stability of value of gold and silver, and the removal of the danger which hangs over the silver market from the existence of large quantities of over-valued silver money in the currencies of France, the United States, and other countries." This, according to the despatch, is to be accomplished by the adoption of bi-metallism on the principle of fixing a ratio "not lower than the average market ratio of recent years, and not higher than the former French ratio of 15½ to 1."

That such a despatch should have been written in reply to one proceeding from the Lords' Commissioners at home, in which they had stated their opinion "that the question of the possibility of maintaining a fixed ratio between gold and silver is one of the most disputable and disputed points in economic science;" and had quoted, with apparent approval, the declaration recorded by the representatives of Her Majesty's Government at the International Monetary Conference of 1878, that "the establishment of a fixed ratio between gold and silver is utterly impracticable;" is a very remarkable incident in the bi-metallism controversy. If this "utterly impracticable" stability between the value of gold and silver be, indeed, "essential to the finances of India," these are truly in a perilous condition; but before accepting the statement literally, let us see what is to be learnt from the accounts.

I find, on examining them, that three of the items of the expenditure of 1888-89, representing nearly two-thirds of the whole £15,028,700, are composed of:—

Interest,	£2,620,800
Railway Revenue Account,	5,615,300
Stores,	1,327,400
	£9,563,500

The item, £1,327,400 for stores, must for our present purpose be struck off, because the exchange on this item forms simply a part of the price of the stores, and was known to be so at the time the stores were bought. The proportion of the Rx. 6,000,000 of exchange attaching to this item may be taken to be Rx. 570,000.

The Railway Revenue Account, £5,615,300, represents the interest and dividends payable in England on capital borrowed there for the formation of railways in India. It is, therefore, an item distinct from the ordinary taxation of the country, and the exchange on the remittance forms a proper charge on the revenue of the railways. Prior to 1881 the railway system of India was carried on at an annual loss to the Government, but since that year there has been a profit varying in amount as follows:—*

	Profit.		Profit.
1881-2,	Rx. 1,110,087.	1885-6,	Rx. 855,700.
1882-3,	,, 491,524.	1886-7,	,, 799,000.
1883-4,	,, 1,163,414.	1887-8,	,, 114,000.
1884-5,	,, 1,164,241.	1888-9,	,, 244,000.

This profit, whatever it may amount to, is, of course, liable for the loss by exchange. At the present time it falls far short of meeting this, but, as will presently appear, there are reasons for believing that an immediate and important improvement in this respect may be counted on. In the latest Government† Financial

* See Burdett's Intelligence, 1886, vol. 4, p. 43; also East India Financial Statement, 1888-9, p. 58.

† East India Financial Report, 1888-9, p. 59.

Report the falling off in the net railway returns of the last two years is explained by the dead-weight of new lines in active construction on which interest is paid, although as yet hardly earning any money. It is added that "meantime the earnings taken by themselves show fairly steady progress, and we may, therefore, reasonably look for early relief from a very large part of the present burden of Rx. 2,150,000 imposed upon us by our railway accounts."* The Report expressly states that "we are at an unfavourable point in our railway finance," and there appears therefore good reason to expect that the deficiency now shown in the accounts will almost immediately be largely reduced.

The third item, £2,620,800 for interest, may, like the last, be expected to undergo some reduction in the immediate future. One of the consequences of the fall in gold prices in the United Kingdom has been an unprecedented demand for sterling securities of the best class, with a consequent lowering of the rate of interest paid on such securities. In the benefits of this movement the Indian Government have had a full share, and in October last the Finance Minister was able to pay off the 4 per cent. loans (which at that time represented the mass of the Indian Government sterling debt), by an issue of a corresponding amount of 3½ per cent. stock, whereby a saving of interest will arise in the current year of £266,310. It is highly probable that additional economies in interest will be practicable in future loans, seeing that the 3 per cents. have been dealt in at 99, and that the 3½ per cents. now sell at 108. Thus it appears that under this item, also, it may be anticipated that even if the exchange should fall below the present point, there are counterbalancing advantages within view which will in all probability neutralise the loss.

The remaining items sum up to £5,465,200. They are chiefly made up of civil and military charges which, although all subject to modification eventually, may not, in the immediate future, admit of reduction. If this be so, every further fall of one penny per rupee will represent a charge on the Revenues of India, in respect of this group of items, of about Rx. 500,000, or, say, £350,000.

There is yet another counterbalancing consideration which must be mentioned, although I have not the means of accurately stating in money the measure of its importance. When Rx. 6,000,000 are represented as being the loss sustained by the Indian

* East India Financial Report, 1888-9, p. 60.

Government by exchange, no allowance is made for the fact that all the loans contracted in England since the value of the rupee fell below 2s. have experienced an advantage on the outward remittance corresponding to the disadvantage complained of on the homeward remittance. For example, the total Government debt in England bearing interest was—

On 30th September, 1880,	£68,852,916
Do., 1888,	94,061,787
Increase,	£25,208,871

This sum was remitted to India at various rates of exchange, beginning at an average of 1s. 7·95d. in 1881, and descending to an average of 1s. 4·89d. in 1888, the general average for the period being approximately, 1s. 6·75d. per rupee, or equal to a profit, so called, on exchange of about Rx. 7,500,000. The same principle may be applied to loans and advances on account of the railways, whereby this sum would be largely increased.

I have no desire to present the position of India in a light too favourable, but, on the contrary, should prefer to deal simply with the facts as they appear. But, at the same time, it is only right to state that the "evils and inconveniences" to which attention has been called are by no means those of a decaying country. The mischievous consequences to the industrial interests anticipated from the fall in silver have not been realised. Capital has not been withheld from India by England. Trade has not fallen away. The very opposite of these expectations has come to pass. The Honourable Mr. Steel, speaking before the Governor-General and Council on 27th January, 1888, stated that "We have much reason to look forward with hope to the future. Agriculture, the great stand-by of the Empire, is flourishing as it never flourished before. The manufacturing interests are prospering and developing, to the great benefit of the country. Trade is growing in magnitude. Communications are being rapidly improved. Our debt, although large, is amply covered by the value of State property." *

The result of our inquiry into the accounts and financial reports of the Government points, then, strongly to the opinion that the facts of 1888-9 do not justify the anxious apprehensions of September, 1886. Difficulties are the opportunities of capable men; and the very capable rulers of India, having shown them-

* Financial Statement, 1888-9, p. 22.

selves equal to overcoming the strain of the last few years, have now the prospect of seeing its severity relaxed. Even if exchange should fall lower than it now is, there will be compensation in diminished interest and increased railway returns; and, what is of even greater importance, the country itself is in the enjoyment of extraordinary prosperity, and so, in case of need, may be expected to present an excellent and improving subject for the operations of the Minister of Finance.

This, then, is the case, as it appears to me, for the evils and inconveniences which the Royal Commissioners regard as proved, and now let us see what their proposals are for counteracting them.

The general object which it is thought desirable to attain is an extension of the use of silver, whereby its old value in relation to gold may be, in whole or in part, recovered. But the only recommendations on which they agree with unanimity are—

First, The repeal of the duty on silver plate.

This is a proposition which is hardly within the region of dispute, the only difficulty in the way of its being effected being, it is understood, the arrangement of the drawback on the plate in manufacturers' hands. On the other hand, it is a suggestion of no great importance in its bearing on the question under discussion.

Second, The issue of small notes based upon silver, which, it is considered, might become substitutes for half-sovereigns, and, also, as twenty-shilling notes, might, it is said, be put in circulation without any alteration of the law of legal tender.*

This proposal is dissented from by two of the Commissioners, and it has not been made clear how the legal tender of silver itself could continue to be restricted to forty shillings, without a corresponding limitation being imposed on notes intended to be based on that metal. It is unnecessary, however, to discuss this question in the present connection, because it is not supposed that the recommendation could, if adopted, have any but a trifling or transitory influence.

These being the only suggestions in regard to which the Commissioners (with the exception above stated) are agreed, and no expectation being entertained that their adoption would have any material or permanent influence on the course of prices or on the relative values of gold and silver, it appears that the second Royal

* Report on Gold and Silver, Part I., s. 173.

Commission, like the first, have failed to agree, even by a majority, to recommend Government or Parliamentary interference in any important form. This, no doubt, is so, looking to the Commission as a whole, but there is a section composed of six Members who are by no means satisfied with a result so futile. They, while concurring with their colleagues so far as they go, record their conviction that the gravity of the evils has been much underestimated. They contend—

(*a*) That the evils arising from fluctuations in the relative value of the two metals—

(1) Hamper the course of trade between countries using gold and silver:

(2) Stimulate abnormally the trade between silver-using countries to the prejudice of gold-using countries:

(3) Discourage the investment of capital in, and consequently retard the development of silver-using countries.

(*b*) That there are evils arising from the progressive and continuous fall in the gold price of silver, which, by its effects on the exchange between gold- and silver-using countries, places the producers and merchants in the former country at a disadvantage as compared with those in the latter.

(*c*) That there are evils arising from a fall in gold prices of commodities, so far as such fall is due to monetary causes.

(*d*) That there are special evils which affect India.*

They further maintain that most of the evils which they describe would be removed by the adoption, "over a sufficiently large area," of International Bi-metallism,† and, although this opinion has failed to receive the support of a majority of the Commissioners, I must, on account of the large amount of attention that has been attracted to it, ask you to consider with me the practical bearing which its adoption would have on the monetary arrangements of the United Kingdom.

The features of the Bi-metallic system which are represented to be essential are—

* Report on Gold and Silver, Part III., s. 4.

† *Ibid.*, Part III., s. 30.

First, Free coinage of both metals into legal tender money; and

Second, The fixing of a ratio at which the coins of either metal shall be available for the payment of all debt at the option of the debtor.*

"The particular ratio to be adopted is not," in the opinion of the six Commissioners, "a necessary preliminary to the opening of the negotiations;"† but once fixed it is not to be altered. There is some indefiniteness in regard to the countries that would require to join in the agreement in order to its becoming successful, but it is stated "that the chief commercial nations of the world, such as the United States, Germany, and the states forming the Latin Union should, in the first place, be consulted as to their readiness to join with the United Kingdom in a Conference, at which India and any of the British Colonies which may desire to attend should be represented, with a view to arrive at a common agreement on the basis above indicated."

The adoption of Bi-metallism in the manner already described having been objected to by the other six Commissioners, on the ground that "the change proposed was tremendous," and that "its very novelty would excite apprehensions which might not be without danger," it is answered "that the system of currency which we now recommend was in existence in other countries for many years before 1873, and its effects practically extended to all the commercial countries of the world. We are not aware that so long as it was maintained in its integrity any evil results ensued. The only novelty in our proposal is that the United Kingdom should join with other nations, specified below in Section 35, in re-establishing a bi-metallic system. We are, therefore, unable to understand how, in view of the experience of the past, any ground of serious apprehension can exist." ‡

Now there is no doubt that there is much to be learnt on this subject from the experience of the past. We know, for example, that various nations, acting independently, have at different times attempted to base their currency on the bi-metallism principle; have fixed the ratio between the two metals at what appeared to them to be suitable; and in some cases, as in our own in past centuries, have altered the ratio when change in the market value seemed to

* Report on Gold and Silver, Part III., s. 34.
† *Ibid.*, Part III., s. 35. ‡ *Ibid.*, Part III., s. 31.

require it. The experience of France in this matter will best repay examination, for, besides being the most recent in point of time, the facts relating to it have been well ascertained, and the nation, of course, stands in the first rank in point of wealth and power. Her experience, then, tells us that "in 1803 the double standard, with a ratio of 15½ to 1, was definitively adopted, and in 1865 the formation of the Latin Union, ultimately consisting of France, Italy, Belgium, Switzerland, and Greece, extended and confirmed it." *

Under this system let us now see from the coinage returns of France what were the movements of the two metals in that country. We have these from 1816 to 1880,† covering two distinctive periods, sufficiently prolonged to show how far the adoption of a fixed ratio operates as a controlling influence when it is at variance with the market value. The true market ratio, according to the elaborate tables of Dr. Soetbeer,‡ of silver to gold, on the average of the years 1821-50, was 15·79, being ·29 above the French legal ratio of 15·50,—equal to a difference of 1·87 per cent., whereby the market value of *silver* was below the legal value. On the other hand, in the years 1851-70 the true market ratio averaged 15·41, being ·09 below the legal ratio, —equal to a difference of ·58 per cent., whereby the market value of *gold* was below the legal value. In the first period, embracing thirty years, France coined £18,148,000 of gold as against £127,636,000 of silver, the gold being only 12½ per cent. of the whole. In the second period, embracing twenty years, France coined £257,443,000 of gold as against £28,377,000 of silver, gold being no less than 90 per cent. of the whole. The movement of the metals was thus plainly not regulated by the bi-metallic law, which was in force during both periods, but by the Gresham law, according to which the less valuable displaces the more valuable metal; and it is because this is so that every nation in its turn which, acting independently and alone, has attempted to base its standard on the bi-metallism principle, has been compelled, sooner or later, to modify the ratio or abandon the principle.

But the new principle which is to remedy the defect inherent in isolated national action is that of Union, for bi-metallic purposes,

* Sir Louis Mallet's Note, p. 107.

† Report on Gold and Silver, Part I., s. 124.

‡ See the translation printed in the Appendix to the Final Report on Gold and Silver, p. 162.

among the leading nations of the world. This principle has found partial illustration in the Latin Union, and it is interesting to ascertain how far their experience throws new light upon the subject. What was to be expected from the experience of individual nations acting independently was, that as long as the adopted ratio was fairly expressive of the market values of the metals, no important consequence would ensue. If a serious divergence of values should happen to take place, caused by an increased abundance of the more highly-prized metal—gold—the nations of the Union would make no objection to the consequent substitution of gold for silver. If the tide should turn, and threaten to deplete the newly-made stocks of gold, they would then have to decide between parting with their gold in exchange for silver, or suspending the regulations of the convention. These circumstances having actually arisen, the nations of the Union found themselves powerless to uphold the conventional ratio, and so elected to suspend the obligation to continue the coinage of silver. As Professor Sidgwick, a *quasi* bi-metallist, has told us, that the difference between the ratio and the market values must not be "too great or too prolonged,"* and the learned professor's opinion was completely justified by the experience of the Latin Union.

Still the six bi-metallist Commissioners, more confident than Professor Sidgwick, are by no means prepared to surrender their case. They think to surmount the difficulty experienced by France acting alone, and by the five nations acting in concert, by simply enlarging the scope of Union. If all the world could be got to join it, then the difficulty, in their opinion, would undoubtedly disappear. If even "a sufficiently large area" would join it, the difficulty, for all practical purposes, would also disappear. To both of which propositions I must oppose a direct negative, and that for the following reasons:—

In the *First* place, the introduction of the United Kingdom into an enlarged Latin Union would be a "novelty," not only as being the admission of a new and important member, but in respect that, unlike any of the members of the former Union, she would be *facile princeps* the great creditor member.

Secondly, The United Kingdom would be the solitary member representative of the gold interest, pure and simple, all the other

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* *Fortnightly Review*, October, 1886.

nations being holders of silver in excess of their wants, while at the same time they, like every other civilised nation, are imbued with a decided partiality for gold.

Thirdly, It being one of the essential conditions of the Union that the debtor may pay his debt in the form of legal money most convenient to himself, it is contrary to reason and experience to suppose that the debtor nations would not pay their debts in silver, of which they have too much, instead of in gold, which they desire to retain.

Fourthly, While, as regards our foreign transactions, the effect of joining the Bi-metallic Union would thus be to put a stop to our customary supplies of gold from abroad, the demand on the home banks for gold would continue and increase. If a bank at home, relying on its legal right to pay in silver, were to decline to pay out gold when demanded, this, according to all experience, would be the most effective stimulus for creating an abnormal demand for gold, and would at once send it to a premium on its conventional value. Gold would then cease to be taken to the banks; hoarding of gold would become general; banking, as now understood and practised, would be at an end, and with it the supremacy of Great Britain as the financial centre of the nations.

Fifthly, The inevitable consequence of this country joining the Bi-metallic Union would thus be that, sooner or later, and probably without much delay, our monetary system, while in name bi-metallic, would become in fact mono-metallic on the basis of silver, and we should illustrate on a grand scale the unfailing action of the Gresham law.

Sixthly, This movement would not be confined in its influence to the United Kingdom. The practical meaning of gold being at a premium, in the circumstances described, is that it has become more valuable as merchandise than it is as money, and, thereupon, it would be reserved for use as a sort of monetary merchandise. The demonetisation of gold would thus follow upon the forced rehabilitation of silver, and one of the chief purposes of the bi-metallists—namely, the raising of prices generally by increasing the effective supply of legal money, would be defeated.

Seventhly, The idea of a Bi-metallic Union presupposes the existence of fairly similar conditions and aims on the part of its members. It has been shown, for instance, to be a fatal objection to the stability of the system that one of the members should be largely and permanently the creditor of the others; but this is the only incongruity that would be developed by a Union such as is proposed. There are nations with banks and nations without banks. In this country we have slowly created a banking system of high credit and security, and have brought its services home to almost every household. By this means we have reached the point at which the practice of hoarding has almost ceased to exist. Our gold, apart from what is required for the arts and manufactures, is in full circulation as money, and the reserves of gold money are readily accessible to our creditors whether home or foreign. In a hoarding country, on the other hand—such, for example, as India—banking, in so far as it exists at all, is an exotic, and the precious metals, instead of being gathered into the banks and made serviceable as part of the machinery of commerce, disappear in quite extraordinary quantities. They are to a large extent hoarded, and pass out of use as completely as if they had been returned to the earth from which they came. From 1850 till 1888,* the net imports of silver into India averaged more than £7,000,000 per annum, making an aggregate in thirty-eight years of £268,000,000. In the last eight years (1881 till 1888) the net imports into India of silver were £54,000,000, and of gold no less than £31,000,000.

These figures enable us to form some idea of the absorbing power of India, a power which is by no means directed only to the standard metal, silver, but is ready to be applied equally to gold. Suppose, then, that alongside of our great dependency there were created a market where silver could be exchanged for gold at a fixed and favourable price, in unlimited quantity, would not the astute Indian merchants avail themselves of it? Would not a hoarding, debtor nation prefer the more valuable and more easily hoarded metal? and would not the Bi-metallic Union thus become a huge international machine for facilitating the transference of gold from the creditor to the debtor nations, some of the greatest of which are without any effective system of banking, and in whose hands, therefore, the gold would cease to perform any useful function whatsoever.

Lastly, In these objections to the adoption of Bi-metallism I have not assumed that any further depreciation of silver is in store for us, nor that the ratio adopted by the Union would be materially different from the present market values. Were these

* Report on Gold and Silver, Part I., ss. 16 and 36.

contingencies, or either of them, to be realised, the process of substituting silver for gold in the United Kingdom would be immensely accelerated, and the tendency to hoarding gold intensified, while the effect at the mines would necessarily be to stimulate the production of silver and to discourage the production of gold. From what has been said, I think it will be admitted that there is room for considerable surprise that the bi-metallist members of the Commission should have reported that they were "unable to understand how, in view of the experience of the past, any ground for serious apprehension should exist" in regard to our joining the Bi-metallic Convention. I submit that there are grounds for the gravest apprehension that we, by joining the Union, would not only be quickly denuded of the gold we possess, but would be rendered impotent to recover it, because we should have surrendered the vast claims we now hold over the gold of other countries, in respect of advances and loans made for repayment specifically in that metal.

The conclusion, then, to which I trust I have led you, as I certainly have brought myself, is that, while a Bi-metallic Union such as is proposed might, to countries oppressed with over-valued stocks of silver, prove to be a highly convenient and advantageous machine for transmuting silver into gold, and thus, in the first place at least, be an important benefit to them, it would, in the United Kingdom, produce a monetary and financial revolution which we are not called upon to undergo. The "evils and inconveniences" complained of seem to me of extremely small account compared with it. The depression of trade is beginning to pass away, and the industries of the country are moving on at a lower range of prices, not greatly different on the average, according to the most authoritative tests, from that of forty years ago. That there should have been a fall in prices is a misfortune to some, a benefit to others. But just as it was no duty of the State to interfere when prices were rising, so is it none now. Then the propertied classes had the benefit, now the consumer and the labourer. Then the cry of complaint was because of the "unearned increment," now because of the unspent decrement. The question whether or not a better standard than gold can be found is fair matter for discussion, but I hope I have made it clear that Bi-metallism, as now proposed, cannot be entertained. It would have been satisfactory if the Royal Commissioners had pronounced emphatically to that effect. They have not done so.

but have left the subject to the judgment of the people; and as the consumers and labourers are in no way interested in promoting by legislation the return to high prices, I do not doubt that the people generally may be relied on to aid those who feel bound to withstand all rash and dangerous innovations directed to that end.

I would, in conclusion, again commend to your attention the evidence to be found in the Blue Books, a complete set of which will be found in the library. The two Royal Commissions have proved barren of the kind of fruit many, no doubt, expected them to have yielded. The first Commission admitted that they had no recommendations to make fitted to dispel the Depression of Trade; and the second has been equally unsuccessful in clearing up the mysterious relations between money and prices; but they are both entitled to our thankful acknowledgments for the large amount of valuable information they have gathered together.

XXIV.—*State Purchase of Land in Ireland.* By MARK DAVIDSON, M.A., LL.B.

[Read before the Economic Science Section, 12th March, 1889.]

INTERFERENCE by the State in the matters of ownership and distribution of land is, if anything is, a topic which a society that meets for the discussion of economic subjects may be justified in dealing with; and on this ground I have thought it right to introduce a question which, at the present time, requires some delicacy in approaching. But I desire at the outset to avow, on the one hand, the impossibility of writing on Irish land without touching on matters on current politics, and, on the other hand, to disclaim entirely any intention of putting forward political views under the guise of economic criticism. It has been my aim, in the pages I shall now read to you, to keep myself free, as far as any of us can be, from political bias, and although I do not boast to be less influenced by it than other men, I hope that any phrase which may appear to savour of special pleading will be put down to error and not to intention.

Up to the time of James I. (or James VI., as we should call him if we were speaking on a Scottish subject) there were two races in Ireland outside the pale. One of these was the old Irish—the people who traced their descent back to the times of the fabulous kings, and boasted a purely Celtic origin. The other race was Anglo-Norman. Its sojourn in Ireland dated from the earliest occupation by the English, and most of its representatives were the descendants of settlers who crossed the Irish Channel at the conquest of Ireland, or soon after. These two classes were both, by the 17th century, Irish in the full sense of the word. They were distinguished clearly by their patronymics: O'Briens, O'Neils, Maginneses, M'Carthys were as surely Celtic as Desmonds, Fitzgeralds, and Maurices were Anglo-Norman; but in other respects the races had amalgamated. It was not only the intermarriages of centuries that had brought about this result: a common opposition to the powerful English aroused a like sentiment of nationality, which was fostered by the adoption, on the part of the immigrants, of the laws, customs, and manners of the aborigines. In English statutes the Irish appear alongside of their companions, the degenerate English, as being virtually one barbarous and savage people.

In the economy of this composite nation, as with many peoples, the relationship of chief and clan played a prominent part. What the precise authority possessed by the head of the sept was it is not possible to settle with accuracy; but, backed by a traditional and almost sacred significance, as in the Scottish Highlands, we may suppose it to have been very great. The tenure of land, as far as the tribesmen were concerned, is also a matter of dispute; but there is no doubt that the right of these people to some sort of support was recognised just as was the authority of the chief. The chieftain was a landlord without a proper title, and the vassal a fixed tenant without lease, or a hired labourer without contract of service. It is perfectly true that when the clansmen lost what land rights they had, they were also relieved of a chieftainly tyranny, which to modern ideas of freedom must seem to have far outweighed their advantages; but we must not forget that the clan system was the one which had naturally grown and was therefore *primâ facie* suitable to the dispositions of the people, whereas the new and more modern plan was not indigenous, and, as it turned out, proved most unsuitable.

At first, what was done was to introduce the English system of land tenure, with all its belongings. The chief of the clan was recognised as sole proprietor of the land; the rules of succession of the English common law were introduced, and the clansmen were thus debarred from any rights in the matter. The Irish land tenures were at the same time declared illegal. Had this been all, it is possible that a common hostility to England and the old tribal prejudices might have maintained matters much as they had been previously. We all know how, even after the passing of the Clan Acts, the Highland clansmen strove to cling, in the face of overpowering influences, to the ideas of their race. The Irish might have stuck to their chiefs, even as landowners, and the agrarian war which has raged intermittently for many generations might never have broken out. But unhappily the chiefs hated England as much as ever; and the century after the abolition of the Irish land tenures was one of continuous turbulence and determined repression. The beginning of the settlement of new men in

Ireland occurred when a rebellion in Ulster caused no less than 2,000,000 acres or six counties to be confiscated on account of the disaffection of the proprietors. The English Government determined to replace these chiefs with Scotch and English settlers. To the settlers no blame can be attached; they went to Ireland, undertaking an unpleasant responsibility in a violently hostile country, the savagery of which they were to mitigate as they were to alleviate its hostility to Britain. To the rebellious chiefs the forfeiture of their estates was only the natural result, in those days, of their act. But the clansmen, who formed the great majority of the population, and who had been already ousted from any legal right in the land, were not considered at all in the transaction. They were thus made to feel what had probably never been brought home to them before, that the English Government had taken away what they must have regarded as the right to live. They were promised land to settle on, but the promise was ill kept. Thus began the Plantation of Ulster, and once begun, it was persisted in by somewhat less defensible measures. People were sent to Ireland by the English Government to inquire into, and, in point of fact, to challenge, the titles of Irish landowners. As may readily be imagined, the old system, recently abolished, was not one in which the title of a landlord was likely to be very easily proved; and the courts examined them so closely, that the slightest flaw was sufficient to escheat the estate and pass it over to the Crown. Hence came a new influx of settlers. Religious antipathies helped to kindle into a furnace the angry passions of the ousted Irish, and in 1641 took place the famous outbreak called, according to political predilections, Rebellion or Massacre, which marks the first crisis in the Irish question.

There was, no doubt, some justification for the action of the English Government. Some attempt to settle Ireland was necessary, owing to the fierce tribal quarrels, and the open disaffection and rebellion of many of the leading chiefs. But though the existing state of things was intolerable, the English ought to have made some endeavour at least to understand the tribal system; and they should not have forced on Ireland a plantation of foreign immigrants if they wished to win over the affections of the Irish people. Still, we are apt to blame too freely the policy of the time—forgetting that there were then few opportunities for English statesmen to become acquainted with the Irish character and with Irish customs. Even the repressive measures of Cromwell were part of a policy, cruel but logical, which, if successful, would have crushed for ever the Irish people, but would have repeopled Ireland with a new race.

Two-sevenths of the inhabitants perished during the struggle that followed the Rebellion of 1641. It was punished by a wholesale confiscation of land, and by a renewed plantation of settlers—these being in great part soldiers of the republican army, who got their reward in this way. The expropriated Irish, although shorn of their property, were not treated very harshly when we consider the mercy commonly shown to people who were stigmatised as rebels in those days. They received land in Connaught, the whole of which province was kept for them. Into Connaught, on a certain day, the remnant of the Irish proprietors had to retire on pain of death, and for the future the three fairest divisions of the country were to be a new Ireland, brought under English civilisation and English religion, friendly and well-affected to the larger island. The vacillating policy of Charles Stuart destroyed all chance of success to Cromwell's experiment, without satisfying the hopes that it raised among the dispossessed; discontent was fostered without being allayed; the firm grasp was relaxed without any tangible relief. At last, under a Catholic king, the Irish made their despairing national attempt to oust the alien and heretic invader. The Irish rising resembles the '15 and the '45; but inasmuch as there was more of genuine grievance on the part of the rebels in the earliest of these Jacobite revolts, it does not shine with the chivalry which has cast a halo even round the weak princes who headed the more recent of them. We could hardly imagine an Irish Jacobite poetry centred round James; yet James was as good a man as either of the pretenders, and a better than either of them; his misfortunes were greater, too, for he lost a crown, while neither his son nor his grandson ever wore one.

After the rout of the Irish in 1690 came more confiscations and a new plantation of settlers, the Treaty of Limerick, with the unhappy misunderstanding that followed it, and a settled hostility between Ireland and Britain, showing itself on the one hand by severe religious enactments and crushing tariffs, and on the other by a lively interest in the cause of any foreign nation which could be induced to quarrel with the English Government. With this event closes the chapter of British interference with Irish land until our own day; here also closes the historical prelude I have thought it necessary to read, even at the risk of tiring my hearers with an oft-told tale. My aim has been to make clear a point which it seems to me of the greatest importance to keep in view, and which is a necessary premise to the conclusions I have drawn—namely, that the land has from the first been the beginning and end of the whole Irish question. Against the final settlement of 1690 the Irish people have been struggling for 200 years; in one form or another the discontent with, and the non-acceptance of, that settlement has been transmitted from generation to generation, and with it the feeling of bitterness against Britain which imposed the galling terms of peace upon them. The form of the thing has changed frequently, but the sentiment is the same. The landowners of Ireland are not all aliens; but for long the feeling has been widespread that in some way these landlords do not represent the Irish people,—are alien in circumstance, or religion, or sympathy, and ought not to be there. There have been many agitations in Ireland; and there have been many cruel and foolish laws passed by the British Parliament against Ireland. The trade regulations were bad enough: the penal laws against Catholics were worse, although the most crushing were those which prevented Catholics from holding land: the abolition of the Irish Parliament, corrupt and contemptible body though it was, was irritating to the country; but the agrarian question has always been at the bottom of Irish disaffection. It is admitted on all hands that the amalgamation of the land agitation with nationalism has made the latter far more popular than it ever was previously, if, indeed, at any time it was really popular. The National League is only the outcome of the Land League. A clever foreigner, who knew Ireland well, while travelling there during the Catholic Emancipation struggle, remarked to O'Connell that what the people of Ireland were really enthusiastic about was the prospect of making a breach in the agrarian settlement, which they expected from the break-down of the Protestant ascendancy. O'Connell, not a very violent land reformer himself, unwillingly agreed.

It is hardly necessary to say that in recent years the agrarian trouble has become more acute with the gradual enlargement of the franchise; new classes of people in Ireland have been brought into the ranks of citizens; in particular, the great agricultural population, comprising about three-fifths of the whole nation. These things could not fail to have their effect on the attitude of the Government to Irish land, and in 1869 began a new era in

Irish legislation. As an accidental circumstance accompanying the disestablishment of the Irish Church, the State found itself in a position to dispose of 108,000 acres of land. The Church Commissioners, who had the business of finding purchasers, were empowered to offer to tenants the right of pre-emption, and where church tenants bought, the Commissioners were allowed to leave three-fourths of the purchase-money to be paid off in thirty-two years, by 64 half-yearly instalments, with 4 per cent. of interest. The Ashbourne Act of 1885 has very reasonably reduced the amount of interest payable by church tenants to 3½ per cent. The next experiment in the same direction was tried in the following year. By section 44 of the Irish Land Act (1870) facilities were given for the purchase by tenants of land which fell to be dealt with by the Landed Estates Court. The Board of Public Works was allowed to advance two-thirds of the purchase-money on mortgage on the land bought, which sum was to be paid off, with interest, at 3½ per cent. in 70 half-yearly instalments. Two-and-a-half times the amount of the church lands fell to be sold under this Act, and the Treasury were authorised to advance as much as a million sterling. The operations under these two Acts were very different. Under the Church Act the tenants were all served with notices of the intended sales, and forms for using their right of pre-emption. The Church Commissioners did everything to make purchase by the tenant easy, but the Landed Estates Court considered it no part of their duty to do so. No forms were sent out; applicants were enjoined to appear by attorney in Dublin, and the expenses and restrictions were many and grievous. Under the 1869 Act 75 per cent. of the tenants bought their holdings at the terms offered in the first eight years; under the Act of 1870 only about 6 per cent. did so in the same period. It must be observed that, although subdivision of holdings is prohibited by both Acts, alienation is only struck at by the later one, so that the church tenants were able to borrow part of the fourth of the price of their lands on mortgage, while the Landed Estates Court not only disallowed this, but frequently cut down the two-thirds of the purchase-price advanced till it came nearer one-half.

A Parliamentary Committee was appointed in 1877 to consider the results of the attempts at creating peasant proprietary in Ireland, known as Mr. Shaw-Lefevre's Committee, and the unanimous opinion of the committee was that the Bright clauses of the Land Act were a dead letter, on account of the difficulties in the way of carrying them out. It was found that at that time less than £400,000 had been advanced out of the £1,000,000 authorised. They recommended greater facilities, and an advance of three-fourths instead of two thirds of the purchase-money; suggested that alienation and assignment of land should not be forbidden to the purchasing tenants, but advised the continuance of the prohibitions against sub-letting and sub-division.

These recommendations were never acted upon, and the next legislative effort was of a very different character. After an attempt to make evictions expensive and troublesome, which was choked in the House of Lords, Mr. Gladstone's Government brought in the great Land Bill of 1881, founded on a new principle altogether. The facts on which this measure was based no one can seriously deny. Rent is in theory, as we know, an economic surplus which is left to a farmer after his expenses and the ordinary rate of profits are deducted. In practice real rent approximates to economic rent most closely where the mobility of capital and labour is greatest, and where farming can be pursued on a large scale. Where farms are small, and the farmers in consequence men of small capital and little general knowledge, and especially where the mobility of capital and labour is difficult, economic rent has no practical existence. Agricultural capital is less easy to transmit than any other kind of capital; and even in favoured countries a farmer will generally accept profits far below the usual rate rather than try to transplant his capital to some other industry. In Ireland the cultivator is neither rich nor intelligent enough to shift his capital when he has any; nor are there outlets for it if he had the means. The average income of the Irish agriculturist—farmers and labourers and their families, excluding landlords—is about £12 a head, and less than £50 for a family of four. Agriculture being thus the only possible industry in most parts of Ireland, the competition for rents, often reckless and unthinking, had so greatly raised them as to render their payment impossible, and the demand for them became a grave social danger.

The Act of 1881 had one central purpose—namely, to give a long lease to the tenant and to fix his rent without competition. The right of selling his tenancy, while it encroached on the advantages of fair rent, gave to the tenant a part-proprietorship in his land. Thus we established what is stigmatised as the Dual-Ownership. The warmest admirers of the Act of 1881 can scarcely claim for it success; but a discussion of its merits and defects is out of place here. The best that can be said for it is that it tided us over a crisis, gave some property to the Irish tenants, and much employment to Irish lawyers. In 1885 the former plan of creating peasant owners was once more resorted to, and this time on a larger scale than before. The Ashbourne Act gave facilities to landlords and tenants who wished to transact for the sale and purchase of land. The parties were left to make their own bargain and fix their own terms; but when this was once done the Land Commissioners were empowered to advance the whole of the purchase money to the tenants, which sum was to be redeemed by yearly payments of 4 per cent. extending over forty-nine years, after which period the fee-simple of the land became the tenant's without further payment. The Treasury were authorised to advance as much as £5,000,000 for this purpose. Last year a short Act was passed authorising other £5,000,000 to be advanced in the same way. These last Acts are both of them very substantial efforts to create a class of peasant proprietors in Ireland.

It will be observed that I have made no mention of the Land Purchase Bill of 1886, a much larger and broader attempt to settle the Irish land question than any that preceded it. It does not come within the category of experimental reforms, and, therefore, I have not classed it even with the Act of 1881; but it is of the nature of an extreme and final remedy, which will fall to be discussed when we are considering the possible solutions of the Irish land difficulty.

That this agrarian difficulty should be met, and, if possible, solved once for all, is a matter on which most people will be agreed. That it should be attempted by the British Parliament is admitted also; the view that an Irish government should be first established and left to deal with the land, I leave out of account, both because it has never been seriously proposed, and also because it is impossible at the present; and it is a present settlement that I wish to consider.

Ten years ago the Irish Land League proposed that Parliament should buy out the whole body of Irish landlords, leaving the tenants to repay the price in instalments spread over thirty-five years, at the end of which time they were to be recognised as owners. This demand was unfavourably received by English politicians, and was replied to by Mr. Alfred Wallace in an interesting paper in the *Contemporary Review*, in 1880. Mr. Wallace dismisses very briefly the peasant proprietary scheme, to which he sees insuperable objections; and he proposes, as an alternative, a plan whereby the State should gradually become proprietor of all the land in Ireland, without incurring either risk or expenditure. His scheme is of two parts: *First*, all intestate estates in land, where there is no near heir, are to be escheated to the crown, on the ground that relatives far removed have no right of expectation to succeed; *Second*, all estates in land, where they have changed hands four times after the passing of the Act, are to be held by the fifth holder only in life-rent, the estate going at his death to the State. Mr. Wallace also proposes a present valuation of all land, to be recorded, and also a valuation of all improvements that can be shown to have been made by the present owners, or by tenants under them. On the basis of these valuations, with deduction of improvements, a rent is to be fixed at the time the land falls in to the State, which rent is to be charged to the tenants, if they elect to remain on the land [illegible] to the person or persons who may take the land from the State [illegible] all improvements [illegible] Mr. Wallace's plan [illegible] distant and [illegible] value of the land.

If we are to have a final settlement of the [illegible] and if the Parliament of the [illegible] of making [illegible] I can hardly imagine that [illegible] are [illegible] I shall not [illegible] [illegible] things go on as they are. We are thus left, as I said, to two alternatives. One is the nationalisation of Irish land, the solution proposed by Mr. Wallace; the other is the formation of a peasant proprietary on a large scale, on the method indicated by the Ashbourne Act and the Land Purchase Bill of 1886.

The former has points in its favour, which Mr. Wallace urges in his article, at the expense of a plan to create peasant proprietors. He points to the fact that under a land purchase act the State would remain entitled to an annual payment resembling rent; and that if this could not be met, the unpopular machinery of eviction must be introduced at the instance of the British Government. He also urges that the peasants would alienate their holdings, even if not permitted to subdivide them, and that in a short space of time we should have holdings massed together in the hands of individuals, and a return of the agrarian difficulty in the old forms. The poor and improvident would mortgage their land, and the rich would buy it up; in a little while the relations of landlord and tenant would again arise, and the Government would be asked to buy the land once more to sell it to a new set of tenant-purchasers. The immediate expense he also considers a great objection. These are, no doubt, difficulties, and form strong arguments against a comprehensive scheme of land purchase; and they are not the only reasons adducible for avoiding such a policy. Whether or not they can be overcome is a question I shall address myself to afterwards: at present I shall give my reasons in brief for thinking that land nationalisation is out of the question.

Mr. Wallace's scheme fails hopelessly, because it is not a present settlement, but one thrown back into what Mr. Gladstone calls a long vista of politics. It would depreciate the selling value of land in Ireland, where it is even now difficult to find buyers, without doing any real good to the tenants. A landlord, who knew his estate to be held for four lives only, would deem it both his duty and his interest to get as much rent as possible during the time that was left to him, and his encouragement to improve would be no greater than it is at present. To the existing tenant it would be no advantage to feel that at one period between fifty and one hundred years hence his successor was to hold his land from the State instead of from an individual; and I do not see how the successor, even when his turn came, would be much the better for it. To be of any use, a settlement must be made now. Can the State become at once, with advantage, owner of all the agricultural land in Ireland? If it can, then a solution of the difficulty is possible on Mr. Wallace's lines; if not, it is impossible.

To begin with, the plan would involve immense cost—say 140 to 160 millions sterling. The British Government would become landlords over all Ireland, with the title to exact rents and evict non-paying tenants. This at once raises two grave objections—*First*, that the tenants will only have made a change of landlord; and, *Second*, that the measures taken to enforce the payment of rent will lead to disturbances and increased ill-feeling against the Government of Britain. The first of these is a good objection. No doubt the State might fairly, in relieving the owners of Irish land of a hazardous and undesirable position, make such terms as to enable it to lower to some extent the rents now paid by the Irish tenants; but however that may be, the peasant would still be as far as ever from the historic desire of his heart—the ownership of the soil of Ireland,—and would not find himself in a greatly altered position. The second objection I think entitled to less weight. It must be remembered that under any scheme of peasant proprietorship the new owners must remain for a long time paying what is virtually a rent to the British Government; and that the purchasers under the Ashbourne Act and the Act of 1888 do so, and do so punctually, as a rule, and without complaint. We have never heard of any disturbance about the paying of half-yearly instalments. Moreover, once the land were taken over by Britain, the position of the rent-collector would be very much stronger than it is now; and I expect that the British taxpayer, as a landlord, would take care to have his rent paid. Still, there would no doubt remain a feeling of antagonism to the Government landlord which is absent when the tenant looks forward to ownership in the long run; and any distress through bad seasons would make the Government very unpopular. But what I think is a grave reason for objecting to land nationalisation is that the State is not likely to manage such an immense and difficult business as the agriculture of a whole country without great loss and waste. It is a bad precedent for the Government to take over a great quantity of property: it is not in keeping with the traditions of the country; and it would lead to constant demands for extension of the principle. Moreover State purchase of land must be a speculation, and a doubtful one. [illegible] unfair and inadequate price be forced upon the owners of land, the price of produce may be still further reduced in some years [illegible], and be very possibility of this involves a risk which the State ought not to incur.

We are thus left to examine what I have ventured to call the alternative solution of the Irish land question. For Ireland it is a remedy that has been long proposed. Mill, forty years ago, writing of the agrarian condition of Ireland, suggested that public policy even then required the State to intervene to make the tenants freeholders. It has been tried, as the various Acts from 1869 to 1888 show: and so far the results cannot be complained of. It is no new thing for a legislature to interfere to institute a peasant ownership; in fact, Britain is one of the few great States in Europe that has not done so. With Ireland in such a state for a century at least that nobody could have been the worse for such a policy, we have trusted in the power of things to right themselves long after our neighbours have taken their land question in hand. In France we know that the rise of the small landowners was a part of the great revolution; but the change has been accomplished peacefully and in our own methods in other countries. In Prussia the work of Stein, and subsequently Hardenberg, was directed to this end; but Stein and Hardenberg virtually failed to accomplish it, because, although the commutation of land dues was allowed in Prussia to the cultivator, the State gave him no assistance in the form of loans. Up to 1847, forty years after the inauguration of Stein's reforms, only 1 per cent. of the peasants of Prussia had become freeholders. In 1850 the redemption of the rent charges was made compulsory, either by a capital sum equal to eighteen years' purchase, or by the payment of 5 per cent. on twenty years' purchase for forty-one years, or 4½ per cent. for fifty-six years. Most of the other German States have made arrangements of the same nature, though varying in details. Russia established her freed serfs on the land, paid compensation to the landowners, and charged the communes with redemption of capital and 5 per cent. interest in fifty years. In Austria, also, the State has interfered to put the cultivators in possession of the soil.

I have mentioned Mill's expressed opinion upon this matter. In 1879 another very eminent economist, Mr. W. T. Thornton, urged the same view. Mr. Thornton wrote before we had the experience furnished by the Ashbourne Act to go upon. But even on the results of the Church Act, and the almost inoperative Bright clauses of the Land Act, he advised a great increase, through State machinery, of the number of small owners. As regards the prospects of peasant proprietors in general, Mr. Thornton's opinion must be admitted to be of very considerable weight. Subsequently, when the question of Ireland had reached a much more critical stage, Mr. Robert Giffen sketched the outline of that remarkable policy for which a great number of other people have got the credit, and which was shortly thereafter clothed in the two famous Bills of 1886. When I say that Mr. Giffen shadowed forth the policy, I do not, of course, mean that he in any way enunciated the political details; indeed, he expressly avoided committing himself to these. But there is too great a similarity between Mr. Giffen's papers in the *Statist* and the *Nineteenth Century* and the proposals of Mr. Gladstone to be allowed to pass unnoticed.

It may be as well to explain precisely what the scheme of land purchase proposed by the Government in 1886 was, not that I doubt that every person I am addressing read the measure through with great care at the time, but because it is possible that the memories of the deceased may have somewhat faded. First of all, a Land Commission was to be appointed to work the Act, secondly, there was defined a net rental, being the rent actually paid at the time, or the judicial rent where it had been fixed, [illegible] deductions which were [illegible] charge, an average percentage of expenses for the [illegible] of bad debts, rates or [illegible] [illegible] Commissioners were to act [illegible] and were to act [illegible] to be twenty years' purchase of the net rental. [illegible] Commissioners had power to [illegible] the landlord or tenant [illegible] without limit [illegible] twenty-two years' purchase [illegible]

These are the [illegible] now for the financial [illegible] from the [illegible] to the [illegible] purchase [illegible] the price for [illegible] cent. in the purchase [illegible] to the loan [illegible]

Irish rates and duties, which were to be paid in the first instance to a British official; the collection of the instalments was to be left to the newly-formed Irish Government.

The provisions in this Bill, which necessitate the machinery of an Irish administration and exchequer, we will leave alone for a little; the scheme is itself independent of these, though the measure was not. Let us suppose such a proposal made for the present without any supplementary measure for altering the relations of Ireland to the United Kingdom. To my mind the ground plan of it is sound, in the sense that it is the only method by which peasant proprietorship can be created by State action, and the method, in point of fact, in which different States have created it. But in detail it is open to very great objections. To begin with, it would be grossly unfair, if rents are to be taken as at present—unfair in this sense, that we have many classes of rents in Ireland. There are rents which have never been fixed by a court, rents where the parties agreed to settle out of court, judicial rents of the first Land Commission, judicial rents revised under the Act of 1887, judicial rents awaiting revision, leasehold rents which up till recently had no chance of revision by the Land Commissioners, leasehold rents which have been before them. The fall in prices since 1882-3 is denied by no one, and therefore we must presume a fall in judicial rents varying according to the dates at which they were fixed. In order to get a fair value for the agricultural land of Ireland, we ought to have a complete and expeditious revaluation of all rents that have not been before the courts since the Act of 1887 was passed, except in cases where neither party wishes a revaluation, and where a rent can be settled out of court. This would be expensive, no doubt, but less expensive in the long run than the continual valuation and revaluation of rents which we seem to have the prospect of at present. The cost would be large, however; we should require a great number of commissioners, and, as the work ought to be got through in as brief a time as possible, capable men would have to be paid highly for giving their services to the exclusion of their own proper business. Without such a valuation, I cannot see how the purchase could be fairly made, and I am pretty sure that such a valuation would reduce rents sufficiently to enable us, if necessary, to recover the costs of it out of the purchase money, and leave the tenants in as good a position as they would have been in had the present rents been accepted as a basis.

It seems to me, again, that the plan had better be carried out thoroughly, if it is to be attempted at all. Admittedly, the remedy is an extreme one; why, then, should we shrink from making the sale compulsory in all cases and transferring the land bodily to the cultivators? Various objections, I know, are urged to this. When this Land Purchase Bill came before the House of Commons and the country, it was the cue of the Government to minimise the number of sales likely to take place, while their opponents piled up the figures most unmercifully. Now, if the security is bad it is a mistake to trust to it at all; but we have done so in the Ashbourne Act, and are continuing to do so. If it is good, on the other hand, we lose no more by advancing 100 millions than by advancing 10 millions. It is urged, however, that on social and political grounds it is inexpedient to remove entirely the landed class in Ireland. I am afraid this is questionable. Without imputing blame to any one, it is still a truism that in the whole of Ireland, except north-eastern Ulster, that class has unhappily lost all influence of any kind. In the Counties of Down, Antrim, Tyrone, Londonderry, and even in other parts of Ulster, I am aware that the state of things is different; and there, no doubt, there would be loss, and considerable loss. But in the rest of the country I cannot conceive how the removal of a social influence already powerless could affect the public in any way; while I do see, in the equitable removal of an unpopular class, a considerable chance of gain both to themselves and to those who are prejudiced against them. There is also a desire expressed that good landlords should remain in Ireland, and bad landlords be bought out. It is a pity that the terms good and bad should have come to be so commonly used in this sense. I imagine that a fair observation of human nature, aided by a certain freedom from prejudice, ought to inform us that good landlords and bad exist pretty much in the proportion of good and bad people of all vocations in themselves honourable; and that where agrarian questions are concerned, we have good and bad tenants, just as we have good and bad landlords. If we take up land purchase merely to buy out bad landlords, or to settle bad tenants on the soil, we are wasting our trouble to very little purpose. But, taking the argument as it stands, we must remember that land changes hands, and that even if—to use a phraseology which I dislike—an estate is in the hands of a good landlord to-day, it may be in the hands of a bad one next year. So that there still remain the possibilities of a renewed agrarian trouble in the future, even if you extirpate the bad landlords as St. Patrick did the snakes, and leave nobody but the best of landowners. Besides, I doubt if the resident landowners would leave the country where they would be really useful. Take a typical instance. Colonel Saunderson is known to be what is technically termed a very good landlord; but he is also a thorough Irishman. Ireland could not afford to lose him, and he would be out of place in any other country. When a man sells an estate in Scotland he does not necessarily become an Englishman. It seems to me that the purchase of their land would redeem many landowners from a very undeserved unpopularity and loss of influence, and be the best chance of restoring to them the position to which they are entitled among their countrymen.

As I have indicated already, I think the terms proposed in the Bill rather more favourable to the landowners than are necessary. Twenty years' purchase was the suggestion of Mr. Giffen; and as he estimated the rental of Ireland roughly, with some deduction, the total price—supposing a wholesale scheme such as I have indicated to be carried out—would amount to £160,000,000. Mr. Davitt, criticising Mr. Giffen, proposed to reduce the nominal rental to £4,000,000, and to offer twelve or twelve and a-half years' purchase; the price being thus £50,000,000. The latter estimate was calculated on the basis that the price of produce is to go on declining in the future even more rapidly than it has done in the past. So anxious is Mr. Davitt to whittle away the landlord's interest down to a vanishing point that he expresses an opinion that in a few years' time most of the land in Ireland will not be able to pay any rent at all,—forgetting that even under present owners such a catastrophe must mean the throwing out of cultivation of thousands of holdings. The number of years' purchase must be fixed, certainly, and possibly twenty years' purchase on the newly-valued rents would amount to a fair price. Of course, it would be a matter of indifference as far as those still to be valued are concerned, because the Commissioners would value them on the footing that they were to be bought at any number of years' purchase which the legislature might have already fixed. If we suppose the reductions to bring down the rental to six and a-half or six millions, in rough numbers, we shall get £120,000,000 or £130,000,000 as the purchase price. Twenty years' purchase, replaced by 3 per cent. annuities, means a safe income of 3 per cent. in place of a precarious one of 5 per cent.;

relief from a great quantity of anxiety, worry, and expense; and the certainty of being able to realise, at par value, the whole nominal price of the land. I do not know that 2¾ per cent. might not be sufficient; the landowners must be content to sacrifice something for the exchange they are making, and their 2¾ per cent. annuities would not sell much below par. If this should appear to make a profit for the British Government out of the tenant purchasers, the remaining ¼ per cent. might be credited to the extinction of the debt due by them, which would thus be earlier paid off. To the tenant, a rent-charge of 4 per cent. on a price at twenty years' purchase means, of course, a reduction of rent by one-fifth; burdens and expenses, which could no longer fall on the landlord, would probably bring this up to the former rental, that is to say, the newly-valued rental; and in forty-nine years this payment would be extinguished, and the land would revert to him in fee-simple. So that the bargain should not be a disadvantageous one for him.

I have now explained what seem to me the essentials of a scheme of land purchase:

1. Thoroughness—that is to say, it must extend to all the agricultural land of Ireland.

2. It must be directed towards the acquisition of the land in fee-simple by the cultivators.

3. It must be expeditious.

4. It involves a revaluation of probably the greater part of the holdings in the country.

5. The purchase price must be fair.

There are one or two other provisions, however, the absence of which would equally shatter the hoped-for results of the best-devised measure of land-purchase. One of these is the absolute prohibition of subdivision. When we consider that the average income of a family of four, of all the agricultural population in Ireland, is under £50 a year, we can have some idea how little qualified most of the holdings are for division. Sir R. Griffiths was of opinion that no farm in Ireland ought to be of less than 25 acres; it is possible, no doubt, that under a freeholding system the cultivators might make a fair livelihood out of a much smaller piece of ground than this. But however this may be, one of the gravest difficulties which has to be met is the excessive smallness of the existing holdings, and it is absolutely necessary to see that they be no further subdivided.

Sub-letting is also a matter on which the State should show no weakness. It has been one of the chief causes of the agrarian discontent of recent years. Gombeenism is a familiar term for a very crying evil,—what we may call the "sweating" of farms. Mr. Davitt has proposed that no charge except the rent-charge should be recoverable by law; and this proposal, which would strike at the whole foundations of sub-letting, seems to me unexceptionable. This plan would also strike at the system of mortgaging land, which, I am persuaded, it is equally essential to get rid of. It will be a constant temptation to a small owner, once he has got his land, to raise money on it for all sorts of purposes. A more pressing temptation will perhaps be that of burdening the land to provide for younger children. One of the witnesses who gave evidence to Mr. Shaw-Lefevre's Commission was a church tenant in Cavan, who had bought his land. He took a very optimistic view, declaring that the purchase scheme was the making of the church tenants; but he wound up by saying that he meant to leave all his land intact, burdened with provisions for younger children. Curiously, Mr. Thornton, commenting on this plan, does not seem to have seen that it merely accentuates all the evils of subdivision. A small holding, quartered among children, may still afford a desperate incentive to each starving proprietor; but a small holding burdened for people who have no obligation to work on it is simple ruin. Above all things, we must allow no burden on the land more than the temporary rent-charge, if we wish success for the peasants.

Restraints and alienation are of a somewhat different character. It may quite well happen that an owner finds he is not able to continue working his land—he may see his way to a more profitable business, or he may be a person who has inherited a holding which it is inconvenient or impossible for him to cultivate. In these circumstances, there can be no reason why he should not be permitted to sell in open market. What is to be feared is, that in time we may have accumulations of land in the hands of individuals, and a new agrarian difficulty to meet. The prohibition against sub-letting would at any rate prevent the system of landlord and tenant arising again in any form; and the present experience of the fate of large landowners will, I think, be sufficient to discourage anything like accumulations of land in single hands.

There is another provision which, it seems to me, it will be very advisable to introduce in any measure of the sort proposed. I have already hinted at the smallness of holdings in Ireland; it is also the case that in many places the poverty of the land is so great that there is little reason to believe that even Arthur Young's pattern peasant proprietor, who turns a rock into a garden, would be able to make much out of it. Mr. Samuel Laing, a Scotchman very favourably disposed to the cause of the Irish tenants, spent some time in Connemara a few years ago, and his opinion is that in some places nine-tenths of the people could not make a livelihood if they had their holdings rent free. Nor will it do to reply that the remedy is to grant these people more land. Reclamation, the same authority tells us, could not cost less than £300 for each holding—say £60 per head of the people planted on the new land. A little land there is, no worse than that cultivated at present, and some reclamation, at expense less than ruinous, might be fairly accomplished. But if Mr. Laing's observations are even moderately correct, emigration is the only remedy for the congestion in certain parts of Ireland. There is a popular idea that this remedy is one resolutely rejected by the people themselves. But we have only to consider how great the annual emigration actually is, even when opposed by the weighty influences which now set themselves against it, to observe that there must be at least exaggeration in this view. Mr. Laing stamps it broadly as a myth. He instances the success of Mr. Tuke's and Mr. Fater's efforts, and quotes a whole batch of parish priests (the class most opposed as a rule to emigration), in support of his position that the condition of the emigrants is in every way satisfactory. If an emigration scheme could be combined with land purchase it would not only give it a much greater chance of success, but confer a priceless boon on the Irish in the poorer districts. The objections to clearances for the advantage of great landowners are not applicable in such an instance, and the well-worn excuse that we require to keep people starving on barren rocks to recruit the army and navy may as well be put into the limbo of stupid absurdities once for all. I am quite aware that the influence of the Catholic clergy generally, for reasons which I cannot think unreasonable from their point of view, will throw their influence strongly against emigration. But past experience teaches us that advantages to the people so evident will be sufficient to override even this opposition.

We can have no certainty that a peasant proprietary would flourish in Ireland; but the chances seem very good. It is true that to point to countries where this method of existence has proved satisfactory is not in itself sufficient proof that it is suitable for all countries and all peoples. The character of the soil, in most parts of Ireland, would not be the difficulty, but the Irish cultivator has never had the opportunity of acquiring those habits of providence and frugality which are essential to his success as an owner. There must be a change here, no doubt. Professor Baldwin, Chief Inspector of Agricultural Schools, had occasion some years ago to witness the results of an experiment of offering prizes for good cultivation to the smaller farmers in some parts of Ireland; and he believes that by some means of the kind the agriculture of the country might in ten years' time be revolutionised, particularly if the peasants owned the land themselves. As far as experience in the country goes, the tenants who have purchased their holdings seem to have no reason for regret. Nor are they backward in seeking to purchase. Three years after the passing of the Ashbourne Act, almost four out of the five millions granted by that Act had been issued or sanctioned, and applications for half-a-million more were under consideration. I do not know how much purchase money has been advanced under the later Act, but I believe, from a reply to a question asked lately in Parliament, that it is already a large sum. Nor are these advances, as is sometimes imagined, granted merely to purchasers in the best-favoured or most loyalist counties, and in Ulster and the north especially. In the six months from August, 1887, to February, 1888, £48,000 was advanced as purchase money in Kerry, £43,000 in Limerick, £28,000 in Cork, and £136,000 in Tipperary.

When the State purchase of Irish land was offered in 1886, in a form which I have tried to show is imperfect and unacceptable, it was coupled with a proposal to form an independent Irish legislature and executive. We are all aware that this last is for the present *de facto* impracticable, on account of the constitution of the existing Parliament, and that in any event it must take long to be accomplished against the hostile forces opposed to it. But I see no reason why the present Parliament should not settle the land question on the lines of peasant ownership. No doubt a number of people rashly attacked the Land Purchase Bill, and made declarations a little inconsistent with a scheme like the one I have sketched. But the politician, that insidious and crafty animal, as Adam Smith calls him, never shows any difficulty in explaining away trifles of that sort when he wishes to serve his party or himself; and there is no reason why he should be more scrupulous when he has a chance of doing public good in addition. These great men have shown already that they expect the Irish land question to be at the last settled in some way of this sort. The Land Purchase Bill was offered, because it would not have been fair either to the new Irish Government or to the landowners to leave it to the former to settle the agrarian question. This proposition is undeniable. Mr. Laing believes that an Irish administration would simply confiscate all the land at once; and unless we are prepared to risk making ourselves a party to such a transaction we must take the land question in hand ourselves. But we ought to go further; and here I must revert to the proposition which I emphasised in the early part of this paper—that the agrarian difficulty is *the* cause of quarrel in Ireland, the corner-stone on which the whole fabric of discord rests. If this be true, we have a singular reason for settling it first, before the experiment of an Irish administration is tried. Land purchase would relieve the landlords of Ireland from anxiety; but, as was pointed out by Sir George Trevelyan when the Bills were debated, there is a vast number of other people, not landlords, who have been drawn into the fray, and who would find themselves on the wrong side under Irish rule. Now, I do not place undue emphasis on any words that Irish politicians may use about these people; but I know that nearly all who could would clear out, even at great loss, rather than wait for the Parliament on College Green. But if it be true that a general scheme of peasant ownership will settle the land question, and if the land is the root of the whole Irish difficulty, then I should think it would require very little time for the impulsive Irish character to drop the bitterness which is so great a danger just now. When a policeman has neither tenants to evict nor patriots to hunt, there is no reason why he should be unpopular any more than anybody else—especially among a people more free than usual (so long as they stay in their own country) from crimes other than agrarian. Every incident in the remorseless conflict of which we have seen so much is connected with the land. Why are members of Parliament imprisoned? Because they are telling people they are right to resist the payment of rent. Why is a shopkeeper boycotted or a labourer threatened? Because the one sold goods to a man who works for a land agent, and the other gave evidence against somebody who fired at a land-grabber. Once make the tenant a prospective owner, and put out of sight the whole system which has come to be so hateful to the people, and there is absolutely no ground left on which to build an agitation. With the disappearance of this agrarian revolt, the violence and danger of the demand for self-government is gone: the sting of Home Rule is drawn. I do not know whether the Irish would persist in their demand or not under these circumstances. I cannot see that there would be much to fear in acceding to it if they did; but at all events we should be able to talk about it reasonably and calmly, and without flying at each other's throats. Economically, an interval of quiet would be a great gain to the Irish peasant himself. We could show mathematically, if it were desired, that under the present state of things he must lose annually a vast amount of time by his politics; they will also cost him money, if, as many do, he travels to proclaimed meetings and makes a point of being anywhere when there is a chance of a row. If you remove these temptations he will become a better cultivator and workman, and will thus stand a better chance of being a good Irish citizen, if, in a few years' time, you are going to endow his countrymen with nationality.

I should not have said that no ground will be left for agitation. Many people believe that the peasants might combine to refuse to pay the rent-charge to the British Government. This has been frequently urged against land purchase, whether combined with Home Rule or not. "You will never see the colour of your money again," said Sir G. Trevelyan, debating the bills of 1886 in the House of Commons. I do not know what reason we have for such a view. The payments of the tenant purchasers under the Ashbourne Act are precisely of the same character as those that will have to be paid in future: in general, I expect they are fixed on a higher scale. So far the amount in arrear is small, notwithstanding the intervention of some bad seasons; the payments are generally made with punctuality, and there is nothing like a resistance to them anywhere. Moreover, such a resistance would be a very hopeless one when directed against the British Exchequer. We need not blink our eyes to the fact that it is the circumstances attaching to the case which makes it so hard for the British Government to apply great force to exact rents: that the repugnance of public opinion to the levying of a sort of war to collect private debts of an unpopular nature gives great advantages to the recalcitrant tenant. Take away the landlord and his personal interest, and replace him by the mass of taxpayers, and you have a very different state of things. The Plan of Campaign, with an unpopular cause to war against, wild force, and much silent sympathy in its favour, and with opponents severely handicapped, drags out a miserable existence in most cases and ends with a compromise at best. What chance would it have to live for a day with British sympathy alienated and British interest directly opposed? Nor, to my mind, will the case be altered if we should in the meantime have created an Irish State. For such a State nothing could be more foolish than to exasperate Britain by non-payment of tribute; it would pay the Irish Exchequer to find the money anywhere rather than raise a *casus belli*. Many people seem to think that in such a case it would be virtually impossible for Britain to attempt military measures to enforce the payment of Irish debt, or, indeed, to check Ireland in any way. So far as my experience goes, the working-classes in this country are under no such delusion; and I do not believe the Irish have any hopes of the kind themselves. Without any great show of force we could reduce Ireland in a very short space of time to abject helplessness; and it is incredible that an Irish State should be mad enough to risk such a catastrophe. On all grounds, therefore, it seems to me highly probable that we should experience no difficulty in collecting the rent-charge so long as it is due.

I shall now close by recapitulating the chief points of the proposal I have sketched:

1. Revaluation of rents of holdings.

2. Compulsory purchase at a fixed number of years' price.

3. Price to be repaid by tenant in forty-nine yearly instalments of 4 per cent. I should prefer the term to be slightly extended, and the annual payment reduced to 3¾ per cent., in case the charge should press heavily in a poor season.

4. Subdivision of holdings prohibited, and no charge on the land other than that of the Government rent charge to be recognised by law.

5. Payment of landowners in perpetual annuities yielding 2¾ per cent. The question of existing mortgages and burdens it would take too long to enter upon, but I should certainly favour a reduction of the terms in family provisions where the rent of the land has fallen greatly since these were made.

The more political portion of the argument has not been introduced with a view of raising the question of Home Rule. In pleading for land purchase at once, without respect to the question of an Irish administration, I have no idea of commenting on or criticising any policy of creating the latter. But I would say that both parties are already identified with one scheme or another of a similar nature to that in this paper—either the Land Purchase Bill of 1886, or the Ashbourne Act, and the Act of 1888. To the follower of Gladstone I say he has more to hope for from Home Rule a year or two after the land question has been settled: and to the Unionist I would suggest that he has less to fear: and that whether Home Rule does or does not come, he ought not to miss an opportunity of solving the agrarian difficulty, which he may never again have. And to all men of moderation and reason I would appeal, to say whether it is not worth while to make an effort, even though it should be only an effort, to put an end to this internecine struggle which has embittered and lowered political life in Britain, and is surely preparing civil war in Ireland.

XXV.—*The Science of Ventilation as applied to Inhabited Interiors.* By D. G. Hoey.

[Abstract of Paper read before the Society, 6th March, 1889.]

Thorough ventilation consists chiefly in two operations, the intimate and invariable correlation of which must always be kept clearly in view, (1) carrying off, regularly and constantly, the air which has become heated, vitiated, and exhausted, by respiration, exhalation, vaporisation, surplus animal heat, and the lighting apparatus, when in use; and (2) introducing fresh pure air in its place. All methods which are limited to one or other of these indispensable adjuncts are, *ab initio*, defective and devoid of title to the name of a scientific system. The apparatus for producing the double action must be capable of easy and immediate control, and of instant regulation to the degree of ventilation required under all circumstances, quite independently of wind or weather. Systems of exhaust which depend on the motion of the outer atmosphere are anachronisms.

The fresh pure air must be introduced at a level low enough to mingle with the coolest and best air already in the room, and yield its oxygen uncontaminated, for the inhalation of the occupants. All irregular entrances for air by open or badly fitting windows, doors, &c., should be closed. The air thus introduced must be imperceptibly diffused and free from sensible current. Entrance doors should be in pairs, and on springs, so that one may close before the other opens. Windows should be double-glazed to prevent the downward currents caused by the large cooling surfaces of glass. In summer, means should be provided for cooling the air; in winter, for warming it before it is passed into the room. Means should be available for effectually preventing the entrance of fog and "blacks."

For carrying off the impure air the most efficient means is an upright shaft, containing a column of air rarefied by heat, communicating at its lower end with the room, at or near the ceiling, where the heat and impurity are at their greatest; and, at its upper end, discharging directly and freely into the outer atmosphere, without the intervention of any foul air chamber, or other impediment to the rapid, uninterrupted, upward velocity of the air in the upright shaft, and its continuous, full, and unrestricted discharge from the top. As the efficiency of the apparatus depends on the heat being maintained, suitable materials or coverings must be used to avoid waste of heat and produce effective insulation, while limiting radiation to a minimum. The upright shaft must be perpendicular throughout, smooth, and free from all turns, angles, or corners; its full sectional area must be maintained at every point in the shaft itself, and in any hood or cowl by which it is covered; such hood or cowl must be so constructed as not to hinder, but to promote the continuous free discharge. The quantity of air removed is determined by the height and free sectional area of the upright shaft, and by the difference between the temperature of the air within the shaft and that introduced below to displace it. If the upright shaft is at a distance, the connections must be so constructed as to conserve its full power of exhaust.

The inter-relation and balancing of the two processes, of admitting fresh air and removing exhausted air, must be kept clearly in view, in any scientific system of ventilation, because they act and react, as cause and effect. These true principles having been ignored, or only partially applied, from the time when Sir Humphrey Davy's system was discarded, down to the present time, it follows, as a necessary consequence, that the systems which have usurped its place are unscientific and marred by essential error. I will now proceed to describe the method which has been adopted, for giving form and substance to the said abstract principles, with the additional and important specialty of introducing the fresh air, for the first time, by imperceptible diffusion, in the greatest abundance.

For the admission of the fresh air, without currents or draughts, a dado, preferably about three feet in height, but which may be somewhat higher or lower, to suit particular circumstances, is fitted at conveniently available parts around the room, with a narrow space between it and the wall; and, on the top of the dado, wire gauze or perforated metal is fixed, in an inclined position, so that nothing may be placed upon it to impede its action. Fresh air is introduced into the dado space, at a low level, and in a lateral direction, to promote diffusion, through a number of inlets, from the outer atmosphere, along the whole line, the total area of these inlets being proportioned to the area of the hot-air shaft (yet to be described) for carrying off the impure air. The total space enclosed by the dado, which forms a fresh air chamber or reservoir, being very much greater than the total area of the inlets from the outer atmosphere, the latter coming into this extended space, and entering in a lateral direction, as explained, thus loses its initial velocity, spreads itself slowly over the interior of the reservoir, gently percolates through the innumerable interstices in the wire gauze or perforated metal, and insensibly permeates the atmosphere of the room at the low level at which it immediately yields an abundant supply of oxygen, to be breathed by the occupants. It is absolutely free from the current heretofore found to set in, from the point of entrance of air, to the point of exit of air, which has been so invariable as to have come to be erroneously designated an "atmospheric law."

The air admitted during summer may be cooled, by means of a frigorific mixture, inexpensive as to cost, contained in a vessel which is placed, when desired, in a space provided in the inlets, by which means the entering air passes over and around the refrigerator, before coming into the dado space. In winter, the air admitted may be warmed, by a heating surface of pipes, fitted along the length of the dado. This heating process is under easy and simple control. Means are also provided, where required, for purifying the entering air from fog and from "blacks."

For carrying off the impure air, the needful column of highly rarefied air can best be supplied by means of a chimney of suitable capacity, with a close-throated fire-grate, or by a connection, properly formed, with any existing perpendicular flue. There should be an opening in the room, at a high level, into an outlet tube communicating with the column of rarefied air in the chimney or upright flue. This communication may be made direct at that level, provided there is sufficient remaining height in the chimney above it; if not, the outlet tube should be conducted down to a low level and the connection be there made with the chimney, with a semi-circular bend, so as not to impede the velocity of discharge. In the case of a distant perpendicular flue, care must be taken to make the connection complete, direct, and properly insulated.

The close throat of the fire-grate, or other entrance into the chimney, at the fire level, or the heating entrance into the distant perpendicular flue, must be just of sufficient area to permit the free passage of the products of combustion, but not to allow other air to enter and cool the chimney or upright flue. Its full power as an exhaust is thus maintained, and the current from the room to the fire, heretofore experienced, becomes non-existent.

Where a fire is not wanted, at any time, as in summer, an arrangement of gas jets, with Bunsen burner, or other appliance to consume a large proportion of air and a small proportion of gas, which raises great heat at small cost and free from smoke, is fitted up, behind the fireplace, to produce the needful expansion of the air in the chimney.

When a suitable chimney or upright flue is not available, the same results are produced by a tube, of sufficient area and height, erected above a sunlight in the roof of the hall, in cases where both lighting and heating are desired to be effected by one means. When lighting is not desired by such means, or where a separate heater is desired, to be used alone, or as an auxiliary to a sunlight, a Bunsen burner, or other like appliance, is fitted in the outlet tube at its lower end. The height and area of the tube must be sufficient to give a column of air, of such capacity as will carry off the impure air from the room, in ordinary circumstances, with very little burning of gas, and keep the exhaust going efficiently, even with the most crowded attendance in the room, by turning on the gas fully. The amount of air taken off by the outlet tube is effectively regulated by either or both of two means—the use of valves and the degree of heat produced.

In order to prevent radiation and loss of heat, the tube should be coated outside with a non-conducting substance; it should also be covered on the top by a revolving hood, such as will prevent ingress of rain and promote free and full discharge of air. The best hood is one round-cowled and open-faced, in perfect equipoise, turning easily and accurately with the wind, and fitted so as to be incapable of being displaced or put off its true balance.

XXVI.—*On House Drains without Ventilation.* By JOHN HONEYMAN, F.R.I.B.A.

[Abstract of Paper read before the Society, 6th March, 1889.]

IN the course of the discussion which followed the reading of a paper by me at the Bolton Congress of the Sanitary Institute in 1887, on "The size of house drains and the use and misuse of traps," Mr. H. R. Newton proposed that, instead of increasing the ventilation of house drains—as I had recommended,—we should rather by all possible means keep sewage free from contact with air, which might be effected to a large extent by keeping the drains always full. (See *Transactions* of the Sanitary Institute, Vol. IX., p. 291.) This idea was not favourably entertained by the meeting, but I concurred with Mr. Newton to this extent, that drains should either be thoroughly ventilated or not ventilated at all, and that it would be distinctly better to have our house drains always full than to have them in the condition which is now generally considered satisfactory, with means of ventilation which are quite inefficient. On further consideration, I am inclined to think that, as a means of protection against sewage gas, a full drain is superior even to a well-ventilated drain. The question at least seems of sufficient importance to merit the careful attention of the members of our Sanitary Section, and I therefore venture to bring it before you.

At first our prejudices are strongly aroused against the idea of keeping our house drains full of sewage; but it is evident that sewage in a perfectly water-tight pipe cannot possibly do any person any harm: no one could tell whether it contained pure water or foul. But, as a matter of fact, there is no reason why the house drain which is kept full should not, as a rule, be full of pure, or nearly pure, water. The whole requirements are remarkably simple, and I can see no serious practical difficulty in the way of adopting the system. The first requirement is that the house drain should be so laid that it shall always remain full from end to end, the sewage overflowing at the end next the sewer. Of course the drain must be water-tight, as all drains ought to be.

The second requirement is that means be provided for flushing the drain periodically, either automatically or otherwise—such a volume of pure or waste water being discharged on each occasion as shall displace the whole contents of the drain. Nothing else is required except attention to some small matters of detail which present no special difficulty. For example, care must be taken that the drain does not syphon into the sewer, and that the flushing tank is not placed higher than the lowest sink or water-closet connected with the drain. The bottom of the tank should be at the same level as the highest part (the overflow) of the drain, but in most cases the top of it might be much higher, giving a good head for the flush. It is also important that the house drain should be no larger than is necessary to contain the house sewage. In hardly any case would this exceed six inches in diameter, and it will generally be advisable that the drain, so far as it is within the house, should be of iron.

In action, this drain would never be more than 24 hours without being thoroughly scoured, and its contents would always be comparatively pure and free from fermentation; so that no harm could possibly result from connecting waste or soil pipes directly with it; for, in the first place, the drain could contain no aërial microbes, and, in the second, each connection would be effectually sealed.

The difference between this system and that in ordinary use may be summed up thus: Under the present system the drains are always full of *air* more or less foul and favourable to the development of virulent microbes, whereas under the other the drains are always full of water more or less foul; and the essential sanitary difference is this—that, while many things prejudicial to health can come out of the one drain, nothing prejudicial to health can possibly come out of the other. The one is a constant source of danger, from which we attempt to guard ourselves by means which have often been proved to be unreliable; the other need give us no concern whatever. The balance of advantage therefore seems clearly on the side of the latter.

XXVII. — *Proposed Scheme for the Collection, Treatment, and Disposal of the Sewage of Glasgow.* By D. M. NELSON.

[Abstract of Paper read before the Society, 20th March, 1889.]

THE problem of how to deal with the sewage of the City of Glasgow, while preserving the purity of the River Clyde, has long occupied the attention of eminent engineers, chemists, and other scientific experts, involving much scheming, labour, and expense, while yielding little else than the fruits of bewilderment and uncertainty as to the successful issue of any one or other of the various processes and methods propounded. Absence of continuity in the schemes promulgated has tended greatly to puzzle the public mind, caused in great measure, as it may be said, by the chemist stepping on where the engineer stepped off, and *vice versa*, instead of journeying on together through the work from the inception to the termination. Without desiring to disparage or question the utility of any of the schemes, I may say that the one I am about to describe has novelty, feasibility, and economy to commend it.

I propose to divide the city into four districts, two north side and two south side of the river. No. 1, being called north-east, starts from the foot of Dixon Street (St. Enoch Square), running parallel with, and conveniently close to, the river and round north side of Glasgow Green, on eastward to a site somewhere on or near the lands of Dalmarnock. No. 2, being north-west, starts also from the foot of Dixon Street, running westward, parallel, and conveniently close to, the river and round by the Queen's Dock to a site somewhere on the lands of Merklands or Whiteinch. No. 3, being south-east, starts from the foot of South Portland Street, running eastward, parallel with, and conveniently close to the river to a site on or near the lands of Shawfield. No. 4, being south-west, also commences at the foot of South Portland Street, running westward, parallel with, and conveniently close to, the river, onwards to a site near Fairfield.

This system of dividing the city into four districts somewhat equal in extent, yet each possessing features peculiar to itself, has many advantages to recommend it, as one or other of the districts might be selected for experiment upon a moderate scale, and afterwards altered or enlarged as matured experience may justify. Finally, all the stations may be proceeded with and adapted, separately or conjoined, to the process calculated to give the best results. While I express no favour for the processes of direct irrigation or filtration as regards Glasgow, I am prepared to admit that it would be difficult to find in the same area four districts, three at least of which possess facilities so favourable to the treatment of sewage in a variety of ways, and all so capable of being extended mechanically to meet the requirements of those outlying burghs which may be conveniently embraced within the radius of the proposed extension of the district.

A description of one of the stations or districts will suffice in a general way to illustrate all four. I take the north-east section. Starting from foot of Dixon Street, I proceed to lay an intercepting canal or conduit, composed of steel plates formed into tubes, each measuring 21 to 25 feet long by 3 feet to 5 feet area, oval in section, with flanged ends bolted to each other and rendered tight by means of a patent elastic joint, so useful in adapting itself to any movement of downward pressure and subsidence or inequalities in the ground. I have formed a preference for such pipes made from steel plates, ribbed and rivetted together, by reason of their cheapness, lightness, and durability, also by reason of the ease and rapidity with which they can be laid and fitted in the track. Even apart from the very great saving here, there will also be in the excavating of ground and shoring of trenches for their reception a saving of nearly one-third as against any other ordinary system of sewerage; and as I am not aware of any one having preceded me in the proposal to employ this form of steel pipeage for the conveyance of Glasgow sewage, and when it is known that its use will effect a saving of about a hundred thousand pounds, it should not be lost sight of, and should act as a stimulant in having the work proceeded with at once.

This steel conduit will be increased in area as it extends towards the sewage station, so as to carry forward what it receives in intercepting the various sewers and covered burns on its line of march. I may state that I have contrived a method whereby storm, rain, and harmless surface-waters may be largely separated and diverted from the crude and offensive sewage, and, after simple filtration, caused to travel at once into the river, instead of flowing on—as it otherwise would do—to the sewage works, causing a wasteful decrease of manurial value, entailing cost of superfluous pipeage and unduly large filtering tanks, not to speak of the wasteful absorption of chemicals and the additional expense that would be entailed by pumping such a vast quantity of useless liquid.

Having thus briefly described my mode of interception and collection of the sewage, I will now describe the treatment of it at the works. The contents of the conduit may either fall by gravitation, or be pumped into a large tank or reservoir supplied with deodorising chemicals, whereby the sewage may at once be rendered innocuous and free from disagreeable smell—the light or surface effluent flowing off through a series of wood grids into another tank, where it is subjected to the action of chemical and mineral substances, and ultimately drawn off and raised by centrifugal or other force to the uppermost of a series of tanks, built above each other, so as to yield a head of pressure and economise ground space, from which it is allowed to flow irregularly through one deposit of purifying material after another, until it reaches a given point—deodorised, filtered, clarified, and chemically pure. It may then either be syphoned into the river, or, more properly, made serviceable to the adjoining factories for boiler-feeding or manufacturing purposes. The heavy or sludge portions of the sewage, being left behind to settle, are then immediately passed through a series of close vessels into deodorising and precipitating tanks, filtering to a condition when it may be pressed into a semi-dry mass, free from disagreeable odour. Following this it may be filter-pressed into cakes or blocks, and allowed to harden in a moderately-heated dry atmosphere, then sawn or ground down to the consistency of rough sand or gravel, and filled into bags, and in this convenient form kept ready for transit to country districts, where it may be scattered over the land as manure.

As regards the cost of the proposed scheme, I may state that an intimate acquaintance with engineering and contract work for thirty years past enables me to reckon that something short of half-a-million of money, the least of the sums yet named, will complete the system now suggested, and fully equip the four district stations which I regard as requisite to carry on the work affecting us as citizens.

XXVIII.—*Biographical Notice of the late Dr. William Wallace.* By John Mayer, Secretary of the Society.

[Read before the Society, 9th January, 1889.]

In his address delivered to the Society at the opening of the present session, our much-esteemed President announced the death of a former occupant of the presidential chair, Dr. William Wallace; and he made some pointed remarks in regard to that gentleman's eminent position in applied chemistry, together with a few feeling and graceful utterances concerning Dr. Wallace as a man with whom he had had much personal and professional intercourse. Dr. Russell also indicated that he would leave to other and more competent hands to give a summing-up of what our deceased colleague and Past-President was to the Society, and to his profession as a scientific chemist. In undertaking, at the request of the Council, to do the summing-up referred to, it is not that I am more competent to do so than many other members of the Society, but partly because I felt it almost to be a matter of duty both to the Society and to Dr. Wallace's memory, and partly because I had personally known him and much of his work for a very long time, probably for a longer time than most other members of the Society, and certainly for upwards of thirty years.

As may be well known to most of the members, Dr. Wallace was for many years most intimately identified with the chemistry and physics of the gas manufacture and gas lighting, and with the chemistry of the sewage question; and in both of those departments of inquiry his death will prove to be a public loss, as it is certainly a very decided loss to the science of applied chemistry generally. He had, indeed, secured for himself in the scientific world a position that was almost unique. The sad event of his death occurred on Monday, 5th November, after an intermittent illness extending over a period of four years or thereby. Until about a month before his decease, however, he was able to take a general superintendence of his business affairs; but his relatives and his immediate acquaintances who were admitted to his sick chamber could scarcely help concluding that his end was fast approaching.

Dr. Wallace, who was fifty-six years of age at his death, was a native of Edinburgh, but it was in this city that he received all his education as a youth. His father, also William Wallace, a landscape and portrait painter of very considerable merit, settled down in Glasgow (when young Wallace was about five years of age), regarding it as the centre of a much wider field for the practice of his art than was the "Modern Athens" at that time. He painted very many portraits of great excellence, numbering amongst his leading patrons the Coatses and the Clarks of the adjoining burgh of Paisley. The late Sir Daniel Macnee, an esteemed member of this Society, regarded the elder Wallace as one of the cleverest draughtsmen that ever he knew. But young Wallace's proclivities, when he began to show any, led him into a very different field of study and professional labour from that of his father. He had the great benefit of being a pupil in the High School of Glasgow when two of the principal masters were Dr. Connell and Mr. Wolski, the teacher of French, two educationists who have rarely, if ever, been excelled in their respective departments in that famous seminary. Young Wallace early showed a marked inclination for the study of chemistry, and by the time that he was fifteen years of age or so he began to attend the Evening Popular Lectures of the late Dr. Frederick Penny, who, as a lecturer in Anderson's College, has left many pleasing recollections in the minds of those who were his students. By-and-by he became a regular laboratory student with Dr. Penny, and after completing his course of study in the "Andersonian" he made a sojourn in Germany, where, at the University of Giessen, he studied for a couple of years under the great Liebig, the "father of organic chemistry," and took his degree of Doctor of Philosophy (Ph.D.) The training which he had the pleasure of receiving under that great master in chemical research and chemical philosophy was ever afterwards shown in Dr. Wallace's own teaching.

On returning to Scotland (in or about the year 1851), he became laboratory assistant to Dr. Penny, his former master, a post which he held for a number of years. When Penny began to be seriously affected by the heart ailment which ultimately carried him off, Dr. Wallace took charge of the Popular Evening Lectures in Anderson's College during two, if not three, sessions—1855-56-57. As many persons are well aware, he was a great favourite with the students. His lectures bore largely on food-stuffs and on organic chemistry generally. If I mistake not, he also took charge for several years of the evening class in chemistry in the Glasgow Mechanics'

Institution, when its home was in North Frederick Street. Of the many students of chemistry who attended the Andersonian Friday Evening Lectures at the time of which I speak I might mention numbers who have since attained distinction. I will refer only to one—namely, my excellent friend Mr. Robert R. Tatlock, whom, after such a long lapse of time, I can, in imagination, still see in his usual bench busy taking notes of the lectures: for I was likewise a student of chemistry under our late Past-President, and subsequently under Dr. Penny. Referring for a moment to the lectures given by Dr. Wallace, I may say that they were well delivered, though not in the *ore rotundo* style which was so characteristic of Penny's discourses. They were highly instructive and interesting, and they afforded Dr. Wallace an excellent opportunity of showing that he had a good mechanical head for small things, as also great aptitude for fitting up chemical apparatus. At this time Dr. Wallace began to give a great amount of attention to the manufacture and purification of coal gas, practical illustrations of which were given to the students by visits to the local gas-works.

Later on he started on his own account as an analytical and consulting chemist, in which capacity he had an extensive practice during the long period of thirty years. His first laboratory, which was in the block of buildings where the Inland Revenue Office now stands at the corner of North Frederick and George Streets, was a familiar place of resort for many well-known local chemists of those days. For the long period of eighteen years prior to his death Dr. Wallace, in conjunction with his two partners, Mr. Tatlock and Dr. John Clark, carried on what was certainly the largest analytical business in Scotland, and was probably not excelled by that of any firm in the kingdom. In one year, 1871-72, it embraced 2,042 analyses, and in the following year it was considerably increased, while up till his lamented death it continued to hold a front rank. The professional work done came largely from the Glasgow district, but also from many other places in Scotland; and from London, Liverpool, Manchester, Middlesbrough, Bristol, Plymouth, and other towns in England; and from Hamburg, Rouen, and other places on the Continent.

Dr. Wallace continued to give special attention to the study of coal gas—its analysis, its manufacture, its purification, its examination photometrically, its economic combustion, &c.; and in this branch of technology he eventually became, and was long regarded as, one of the leading authorities in the United Kingdom. His position as an expert in gas matters was early recognised by the Glasgow Magistrates. As an expert he was employed by the City Authorities about twenty years ago in connection with the parliamentary action which resulted in the passing of the Glasgow Corporation Gas Act of 1869; and that was followed by his appointment to the office of Gas Examiner for the City, in which capacity he had to conduct weekly testings at several stations. He retained this office up till his death. For about two years he was likewise Gas Examiner for the Burgh of Paisley, and he had also made professional examinations of gas in London and other English, as well as Scottish towns. He devoted much of his time, more especially during the ten years, 1868–1877, to analysing and testing for use in gas-making upwards of 200 varieties of Scotch coals, including cannels, splints, shales, &c., as also samples of such minerals from American, Australian, and other foreign coal-fields. His results were embraced under various heads—such as the physical properties of the minerals, the composition of the volatile matters contained in them, the composition of the coke which the minerals yielded, and, in respect of the gas, its yield per ton of coal, its illuminating power, its sperm value, &c. These analyses, which were ultimately published in a collected form, are still regarded as being of the highest value to gas managers, directors of gas companies, gas commissioners, &c. While speaking of the work done by Dr. Wallace as an analyst, I may also here mention that prior to the year 1876 he had made something like 2,000 analyses of ironstone of various kinds, limestones, fire-clays, furnace coals, pig iron, and blast furnace slags. Of these a number of examples illustrative of the Scottish iron manufacture were published in that year in a volume on "The Leading Industries of Glasgow and the West of Scotland"—one of three guide-books presented to the members of the British Association at the Glasgow Meeting of that year, by the Local Reception Committee.

Continuing to speak a little further regarding his connection with the science and practice of the gas industry, I should state that the first published paper in this department of his work, of which I can find any notice, was entitled "On Some Points in the History of Coal Gas," a subject which he treated in a lecture delivered at the annual meeting of the North British Association of Gas Managers in 1869. His next paper was "On the

Economical Combustion of Coal Gas." It was an experimental discourse which he gave in March, 1874, to the Philosophical Society of Glasgow, whose membership he entered in the year 1851. This was a most comprehensive and interesting paper; and it showed that Dr. Wallace had an extensive and intimate acquaintance with the gas-burners that had up to that time been brought into notice. In the year 1874 the members of the North British Association of Gas Managers had the pleasure of hearing a discourse from Dr. Wallace on the influence of pressure on the illuminating power of coal gas; and on that occasion he also had a paper on a new system of photometry for gas. Three years later, at the annual meeting of the same Association held in Stirling, he gave another lecture, the subject of which was "The Bunsen Burner." In the course of his exceedingly interesting remarks, he not only described the burner in detail and the character of the flame produced by it, but also showed the various modes of applying it in practice in the laboratory.

A marked recognition of the position now secured by Dr. Wallace in connection with the development of the illuminating properties of coal gas was made in the year 1877, at the Plymouth meeting of the British Association, on which occasion a Committee, which included himself, Professor Dittmar, of Anderson's College, and the late Mr. T. Wills (a great authority on gas matters), was constituted for the purpose of reporting on the best means for the development of light from coal gas of different qualities. Dr. Wallace was appointed Secretary, or "Reporter;" and in the following year, at the Dublin meeting of the Association, Part I. of the report, which had been drawn up by Dr. Wallace, was submitted. Part II. of the report (which was drawn up by Mr. J. Pattinson, of Newcastle-on-Tyne, who had taken the place of Mr. Wills on the Committee*) dealt chiefly with gas made from common bituminous coal of the Newcastle and other coal-fields; while Dr. Wallace's portion of the report had reference chiefly to the use of cannel gas, such as is supplied in most towns of Scotland.

In the year 1879 Dr. Wallace communicated to the Philosophical Society of Glasgow a paper bearing the title, "On the Heating Power of Coal Gas of Different Qualities," in the course of which he worked out the general fact that gas of low illuminating power is the cheapest for heating purposes. About this time

* Mr. Wills died before completing his share of this important piece of technical work; and in his early death science suffered a great loss.

he also gave attention to the condition in which sulphur exists in coal—a subject with which he dealt in a paper read before the Chemical Section of the Society. Within the last three or four years the deceased was much associated with Mr. W. Foulis, the General Manager of the Glasgow Corporation Gas-Works, in prosecuting an inquiry as to the propriety of reducing the illuminating power of the gas made in Glasgow, in consequence of the Corporation Gas Committee having resolved to ask for parliamentary powers to make an important change in this direction.

In connection with his investigations regarding coal gas and its economic combustion as an illuminating agent, Dr. Wallace was again made the subject of very marked recognition, for in the year just mentioned (1879) he obeyed a call from the Society of Arts, London, to read a paper on "Gas Illumination," for which he was awarded one of the silver medals of the Society.

As makers of gas-burners and patentees of new gas-lamps are well aware, Dr. Wallace was extensively consulted in reference to such inventions, and commissioned to report upon them professionally. One of his most important pieces of work in connection with gas matters was to serve as a juror in the Exhibition of Gas and Electric Lighting Appliances held under the auspices of the Philosophical Society in the year 1880. The work which he had to do on that occasion, in the way of testing and reporting upon gas-meters, governors, &c., was very great, and of permanent value. His fellow-jurors freely admit that the work was his and not theirs.

For a number of years our deceased Past-President also held a sort of unique position in connection with the sugar industry. So far back as the year 1859 he gave a lecture before this Society on "The Chemistry of Sugar Refining;" and, again, a few years later he gave a discourse on "Animal Charcoal in Relation to its Use in Sugar Refining;" and this was very shortly followed by one on "The Chemistry of the Sugar Manufacture and Sugar Refining." He was now regarded as the leading authority in the kingdom in respect of the science of the industry which is practised in the neighbouring town of Greenock on such an immense scale; and, as an evidence of the estimate which professional chemists had formed of him in that branch of applied chemistry, he was invited by the Chemical Society of London to give a discourse before the Fellows, the subject of which was "The Chemistry of Sugar Refining." He was thus, in a great measure, the pioneer of the application of chemistry to sugar refining, and he continued for a number of years to act as chemist and technical adviser to the leading houses engaged in that industry. In course of time, however, as refiners and their chemists began to devote themselves to the solution of chemical problems bearing upon their manufactures, his services as a specialist were less required.

Dr. Wallace was extensively employed from time to time by the Glasgow Municipal Authorities to inspect and report on sewage systems in operation in various parts of the country, and to carry out important analytical investigations locally, for the purpose of enabling them to endeavour to solve the great sewage problem—which still seems to be as far from solution as ever. The various reports which he prepared in response to the commissions which he received are of very great value, and form a permanent record of the high position to which he attained in this department of public policy and technical research. Municipal bodies in other parts of the country also felt it to be their duty to avail themselves of the professional services of Dr. Wallace in connection with schemes for sewage utilisation and water supply. One of the Glasgow Health Lectures delivered in 1881 was given by him, the subject being "On Water and Water-Supply." On another occasion he delivered a course of four public lectures under the auspices of the Lord Provost, Magistrates, and Town Council, when he dealt with—"The Air of Towns," "The Water-Supply of Towns," "The Disposal of Sewage," and "Food and its Preservation." Those four lectures, which were subsequently published in a volume, enable one to form an excellent notion of the scientific character of Dr. Wallace's mind, and of the manner in which he treated important problems of a practical nature. At the Glasgow Congress of the Sanitary Institute he read a paper on "Some Sanitary Aspects of House Construction." In this connection I may here mention that one of his Philosophical Society papers was on "Air and Water in Relation to Public Health," and another was on "The Germ Theory of Putrefaction." On one occasion he placed the architects of Glasgow under a debt of gratitude to him by giving them a discourse on "The Chemistry of Building Stones."

As already mentioned, Dr. Wallace became a member of this Society in the year 1851, but it was not till the year 1870 that he became a member of Council. He subsequently served in the Council for a second term of three years, by-and-by becoming one of the Vice-Presidents, and eventually filling the office of President with great acceptance for the usual term (1879-1882). He was an honorary member of the Gas Institute, and of the North British Association of Gas Managers, and a Fellow of the Royal Society of Edinburgh, of the Chemical Society, and of the Institute of Chemistry.

Dr. Wallace will long be remembered as a zealous servant of science, an excellent citizen, and a faithful friend. In testimony of the respect in which he was held by his fellow-members of the Glasgow and Scottish Section of the Society of Chemical Industry, the first meeting of the present session, which was to have taken place on the 6th November, was postponed till the 12th. A few members assembled on the first-named date, when the Vice-Chairman (Mr. R. R. Tatlock) alluded in feeling terms to the loss the Society had sustained in the death of Dr. Wallace, and of the loss which the event had brought to him personally; the deceased having been his partner in business for a long series of years, during which, he said, the slightest dissension had never arisen between himself and his friend thus prematurely removed.

By the papers which he communicated to the Society and to its Chemical Section, and by the work rendered in other ways, Dr. Wallace conferred upon the Philosophical Society of Glasgow benefits which none of us can estimate at their full value. He loved it well and loved it long, and he served it faithfully. Many of us who knew him long and intimately feel that he has left a blank which will not easily be filled up.

Looked back upon in his social relationships, alike in his family and amongst his fellow-men, the deceased was kind, gentle, and loving, so much so that, even under great provocation, scarcely ever did an angry word escape his lips, and if it did it seemed, almost as soon as said, to be repented of. His forbearance was altogether what we rarely see, yet it was combined with a calm firmness that impressed his more intimate friends with the evenly-balanced tenor of his mind. His conversational powers—drawing on his rich stores of knowledge—were considerable, and at all times they were much enhanced by his willingness to communicate that knowledge to anyone who presented a question for discussion, while his candour and probity made his opinion of real value. He was one whom to know intimately was to respect and love; and all who so knew him will say that he has left only pleasant memories.

XXIX.—*Biographical Notice of Edward Maxwell Dixon, B.Sc. (London), late Headmaster of Allan Glen's School, and formerly Secretary of the Philosophical Society of Glasgow.* By JOHN G. KERR, M.A.

[Read before the Society, 1st May, 1889.]

EDWARD MAXWELL DIXON was born on the 25th July, 1829, at Knowehead, near Springkell, in the county of Dumfries. His earlier years were spent in Cumberland, for his parents removed in 1830 to a farm near Armathwaite, on the Eden; and thus it came about that, while of Scottish parentage and descent, and marked by all the strong characteristics of his people, his sympathies and desires up to the very last turned towards the rich woodlands and cosy quiet hamlets of Northern England. One little corner of Scottish soil held firm grip on his memory and affection, for he often spoke of his cheery school-days at Kirkpatrick-Fleming, and his trouting exploits on the Kirtle Water. The seven years which he spent here with his grandfather bring us to 1843. In this year we find him living at Broomhills, near Carlisle, and enrolled as a pupil under Mr. Joseph Hannah, of the Abbey Street Academy. His schoolfellows of this period speak of him as an eager, thoughtful boy, fond of his studies, with a decided turn for problems of all sorts; one in whom there was a strong love for nature, and with habits of observation constantly cultivated. Although never of very robust health, he was an active pedestrian, and an enthusiastic disciple of Izaak Walton. Mr. Hannah soon discerned the lad's quality, fostered his special tendencies, and encouraged him in his efforts. Evidence of his progress may be found in some short papers and mathematical solutions contributed by him at the age of seventeen to a scientific magazine, and in the fact that in 1846 he was appointed to an assistantship in the academy. As the course of events determined that Mr. Dixon's reputation should rest more on his power and influence as a teacher than on his work as an investigator, it is of some interest to learn that in these years of his novitiate he gave strong indications of control over boys, carefulness and patience in the discharge of his duties, and unusual clearness in his explanations. The inscription on a testimonial presented to him in 1848 by the pupils of this school supports the words of praise which now come from those who were in touch with him forty years ago. But it must be remembered that, however excellent were the qualities which he possessed, it was a matter of great moment that he received his education and training under one who combined with sound scholarship all those gifts which are needed for successful teaching. In the summer of 1852 Mr. Dixon came to Glasgow with the object of still further qualifying himself for his profession, and became a student of the Church of Scotland Training College for Teachers.

The reputation which he made for himself during his course there, and other distinctions to which he attained, secured for him in 1853 the lectureship on Mathematics in that college. For nearly a quarter of a century he held this office, and it would be difficult to over-estimate the influence which he exercised upon the present race of teachers. This influence was due not merely to the nature and scope of the subjects belonging to his section of the curriculum, but more especially to the methods of treatment which he pursued. The student felt himself suddenly bereft of all fictitious aids, and the distinction between casual information and systematised knowledge stood forth in frigid clearness. Then came the complementary process, which, however, was not so much the building up of an intricate and well-designed structure of facts as the rigorous disciplining of the mental powers with skilfully-arranged problems in mathematics and physical science. Few men possess the fulness of knowledge, the sharp discernment of essentials, the precision of thought, the quick perception of the routes to error, and the simplicity of language, which made every lesson given by Mr. Dixon of permanent good—both from the matter and the manner of it. Intellectual effort was demanded, was compelled, yet seemed spontaneously given, and all aimless straying was controlled by a master-mind; and, as mental processes were of more consequence than quick returns, so it has happened that his endeavours to induce right habits of reasoning and of acquiring knowledge have touched to the core the education of the West of Scotland. The period which, in retrospect, gave Mr. Dixon greatest pleasure extended from 1854 to 1860. His department had then reached a very high level; he had received one of the very few Physical Science lectureship grants offered by Government to

Normal Colleges, and work proceeded with enthusiasm and success. The note-books belonging to students of that period—and most of these students are now the leading men in their profession—testify to a wide scope of exacting study, to well-balanced and invigorating instruction, and to the acquirement of habits of accurate and capable work.

In 1860 Mr. Dixon became a member of the Philosophical Society of Glasgow, but it is in 1874 that we find the first contribution of importance by him to its *Proceedings.* On December 21st of that year he read before the Chemical Section a paper on "The Estimation of Phosphoric Acid." The paper started with a discussion of the principles on which the examination of analytical processes should be conducted. He showed that it was not admissible to use sulphate of soda in making up magnesia mixture, and he brought forward eight sets of experiments made for the purpose of determining the influence of various alkaline salts upon the estimation of phosphoric acid. This paper was supplemented on January 18th, 1875, by a further examination of this important process, and in both papers the author exhibits command over laboratory practice, familiarity with the results of Continental chemists, and a calm judicial mind. All his scientific work is marked by these qualities, and one reads, for example, his criticism of the arguments and experiments bearing upon the theory of the constitution of ultramarine, or the account of his own inquiries into the conditions for successful brewing, with the feeling that if fortune had placed Mr. Dixon in control over some department for scientific investigation both science and industry would have materially benefited. The research with which his name is chiefly associated sprung directly from one of these inquiries into the exact state of knowledge regarding some outlying point in chemistry. I refer to the set of statistics upon the condition of Glasgow Air with which Mr. Dixon, in conjunction with the Medical Officer of Health, furnished the Town Council of Glasgow during the years 1877 and 1878.

In 1875 an inquiry into the production of nitric acid from the free nitrogen of the air was made by Mr. Stanford, Dr. Clark, and Mr. Dixon. The report which was drawn up and presented to this Society by Mr. Dixon is printed in Vol. X. of the *Proceedings.* In it he gives an account of all the leading evidence on the subject, and, after weighing the opinions and experiments of Schönbein, Meissner, Bohlig, and Carius, he concludes that (1) free nitrogen is oxidised by the passage of electrical discharges through the air; (2) it is yet doubtful whether the free nitrogen of the air is oxidised when brought into contact with substances undergoing oxidation; and that (3) there are no other conditions under which nitric acid is known to be formed from free nitrogen.

While working at this report a wider field suggested itself, and Mr. Dixon began to arrange apparatus for the continuous sampling and testing of air in different localities. His combination and processes were exhibited before the Chemical Section of the British Association at the Meeting held in this City in 1876; and during the two succeeding years the collection of information regarding atmosphere impurities was carried on at various stations in and around Glasgow. The air examined at a station on Eaglesham Moor supplied a standard for comparison. No scientific man can question the advisability of having such statistics as Mr. Dixon sought, and no one familiar with the investigation can fail to appreciate the fertility of resource which overcame the mechanical and chemical difficulties, and the administrative ability which organised and carried out the scheme; and we must bear in mind "that, with the exception of the observations made at Montsouris, near Paris, there had been no other analysis which represented or aspired to represent the condition of the air of one locality continuously, night as well as day, for a succession of months."—(Dr. J. B. Russell.) The completed appliances for a station had the merit of compactness and portability. An injector, acted on by Loch Katrine water, produced a free passage of air through a recording meter and through sets of absorbing tubes, in which the carbonic acid, sulphur, chlorine, and ammonia present were separated out and retained for measurement. The details of the process were put before the Chemical Section of this Society in 1877, in (1) a paper entitled "Injectors and other Laboratory Appliances," and (2) a lecture on "The Examination of the Air of Glasgow." In addition to these contributions, for which the Society was indebted, Mr. Dixon did good service as its Librarian (elected 1875), as a member of its Council (elected 1876), and as its Secretary (elected 1877).

But he was not long able to devote attention either to the Society or to this laborious investigation, as the claims of Allan Glen's School, to which he was appointed headmaster in 1878, were beginning to absorb his whole energies. To the organisation and development of this school he devoted the last eleven years of his life with unswerving fidelity. The trustees of Allan Glen had been fortunate in their choice, and he himself now found a sphere of labour in which his genius for administration had free play. However brilliant may be the future of this institution, Glasgow will ever recognise its great debt to the late headmaster. A special Act in 1876 gave the trustees power to enlarge the scope of education, and the school put aside its humble function of giving elementary education gratuitously and became a secondary school, offering a sound scientific training. "The trustees," says the report of 1878, "sharing in the hope, expressed by Sir Joseph Whitworth, that means may be found for bringing science and industry into closer relation, have kept in view the importance of scientific knowledge in the manufacturing arts, and have made provision for a comprehensive and systematic course of instruction in the chemical, physical, and mechanical sciences." Within the last year, under Mr. Dixon's guidance, very extensive changes were made in the accommodation and equipment of the school by the addition of large physical and chemical laboratories, workshops, and drawing rooms, and the Allan Glen School takes rank among the best technical schools of Britain. The organic completeness which now distinguishes it was not due to haphazard or even tentative changes, but was the direct product of matured thought, full knowledge of educational wants, and the deliberate study of those examples which Germany and France afforded. The scrupulous care, prudent forethought, and analytic capacity with which Mr. Dixon attacked this, the greatest problem of his life, are revealed in the various papers on scientific and technical education which he submitted to this Society in 1879 and 1882, and to the International Conference on Education held in London in 1884. The paper on "The Present Position of Scientific and Technical Education in Germany," published in Vol. XII. of the *Proceedings*, is a most lucid statement of personally-acquired information, is rich in valuable criticisms and suggestions, and describes the lines on which the development of his own school was proceeding. These services which Mr. Dixon was doing in the cause of education, and his claims to be placed among the educational authorities of this country, received formal recognition in 1884 from the Council of the International Conference on Education, who elected him Honorary Secretary to the Technical Teaching Section.

From 1884 to the beginning of the present year the increasing requirements of Allan Glen's School laid a heavy tax on Mr. Dixon's strength. Changes in the arrangements of the Science and Art Department had to be provided for; heavy grants must be earned, yet a high standard of mental discipline and a connected system of scientific education must be maintained; the buildings must be extended, and improved facilities secured for physical and workshop teaching, and for art classes. These and other demands had to be met, and to a man of Mr. Dixon's temperament and habits there must be no element of uncertainty regarding the relative values of available methods. Accordingly, it may be said that during these four years the affairs of the school, to the complete exclusion of almost every other interest, occupied his thoughts and exhausted his energies. Only one form of relaxation did he allow himself, and in his favourite study of astronomy he found a pleasant relief from the worry of management.

Towards the end of last year there were evidences that rest was needed, but unhappily during his holiday at Silloth he suffered from an attack of some gastric ailment. Shortly after his return in January to his residence in Glasgow there was a serious recurrence of the illness. During its course there was one short interval of hope, only to be followed by grave anxiety and deep sorrow.

On the morning of February 7th, 1889, Mr. Dixon's life ended, and education suffered a great loss.

XXX.—JOSEPH J. COLEMAN.

Joseph J. Coleman was born in 1839, and died on 18th December, 1888. The son of a Lincolnshire chemist and druggist, Mr. Coleman was left fatherless when he was about ten years of age, and in the course of the next few years he became connected with a business of the same kind as his father's in the town of Halifax. Being studious, and of a scientific turn of mind, he entered several classes in the Mechanics' Institution of that town, attaining such great proficiency in chemistry and other branches of science that he received a number of high awards of merit. When he was about 22 years of age he stood so high in his scientific attainments that, at the Oxford meeting of the British Association (1860), two papers were accepted from him to be read in the Chemical Section. One of them, which dealt with some important relationships of the atomic weights and volumes of the chemical elements, was honoured with a place in the *Proceedings* of the Association for that year. This circumstance seems to have influenced him in becoming a teacher of science, as he afterwards held the position for several years as science tutor in three leading educational establishments, one of which was the Training College at Chester, which at that time had the Rev. Dr. Rigg as its Principal.

About the time of which we speak, the invention of the late Dr. James Young, the "Father of the paraffin industry," had become such a success that many persons in other parts of the country determined to follow his example as manufacturers of mineral oil. In Flintshire, and but a short distance from Chester, a rich bituminous mineral, known as "curly cannel" was discovered, and when it was found to yield to suitable treatment all the products obtained from the Boghead coal or Torbanehill mineral which James Young used at Bathgate for a number of years, the "oil fever" broke out in that county in a remarkable manner. Mr. Coleman, as a skilled chemist and general scientific expert, was tempted across the Dee into Flintshire to erect and manage a works for the manufacture of mineral oils. The fame of his skill travelled to Glasgow, and the directors of Young's Paraffin Light and Mineral Oil Company were induced to offer him a post in their service as an expert to carry out original experimental investigations in the hope that one or more of their so-called waste products might be turned to profitable account, and that certain of their marketable products might be made more profitable. He accepted of the post, and he was not long in showing his employers that they had made a good choice. Brief reference may here be made to two points only. In his experimental investigations he was enabled to show that the uncondensed gases produced in the distillation of the bituminous shale were capable of yielding, to great pressure and low temperature, highly volatile liquid hydrocarbons, having great solvent powers on various substances, and serviceable in producing illuminating gas where ordinary coal gas was not obtainable. He also turned his attention to the improvement of preparations which were then being sent out for lubricating purposes, and in both cases he was remarkably successful.

In dealing with the uncondensed hydro-carbon gases from the shale retorts he devised a machine which developed the required low temperature and the great mechanical compression. In Mr. Coleman's earlier experiments on the mechanical production of low temperatures he had the benefit of the counsel of Sir William Thomson, who for many years took a keen interest in Mr. Coleman's scientific work. This intimacy led to Mr. Coleman being consulted by Mr. James Bell, the well-known shipowner and importer of fresh meat from the United States by the Anchor Line steamers. For some time the method of refrigerating fresh meat in the holds of steamers while crossing the Atlantic was to circulate through the meat chambers air that had passed over extensive surfaces of block ice—a method which was expensive and occasionally inefficient. Mr. Coleman was requested to set his mind to work to try if he could not devise some thoroughly efficient system of mechanical refrigeration. He eagerly entered into the spirit of Mr. Bell's suggestion, and in order that he might devote his undivided attention to the solution of the problem put to him he quitted the service of Young's Paraffin Light Company. What may be regarded as a "New Industry," that of providing the teeming thousands of our home population with fresh meat from North and South America, and from our Australian and New Zealand colonies, at comparatively moderate prices, is of such recent origin and growth that it is scarcely necessary to enlarge upon it. Mr. Coleman was not long in solving the new problem of mechanical refrigeration. Some ten years ago or thereby his first machine, which was practically perfect, was made in the Anchor Line Engine Works, and very soon thereafter the Circassia, Anchoria, Bolivia, and Devonia were fitted with Bell-

Coleman dry-air mechanical refrigerators; and at one time as many as twelve steamers belonging to the fleet of Messrs. Henderson Brothers were carrying fresh meat from the United States to Glasgow, Liverpool, and London. In a very few years the demand for refrigerating machines became very great. The Bell-Coleman Company eventually supplied well-nigh 100 of their machines, of which between 60 and 70 were made by Messrs. D. & W. Henderson & Co.

About four years ago Messrs. Haslam & Co. of Derby, bought up the Bell-Coleman patent rights, and Mr. Coleman having made a moderate competency, retired from active business pursuits. He settled down at Bearsden, built in connection with his residence a spacious laboratory, and resolved to devote his remaining years to purely scientific pursuits. Here it was his intention to carry on original experimental investigation with the view of enlarging the boundaries of chemical and physical science, and so long as his constitutionally frail health would allow him he did excellent work, the results of which were communicated to learned societies.

He was for nearly twenty years an active and efficient member of this Society, in whose *Proceedings* there are numerous valuable papers to which his name is attached. Mr. Coleman had frequently served on the Council of the Society; he was for some time President of the Chemical Section, and at the time of his death he was the senior Vice-President of the Society. The institution of the Graham Medal and Lecture Fund was largely owing to his exertions. He was sent in 1887 by the Council to the Governing Board of the Glasgow and West of Scotland Technical College, as their first representative. To the Institution of Engineers and Shipbuilders in Scotland, with which he was also connected for about the same period, he likewise contributed papers, as also to the Royal Society of Edinburgh, of which he was a Fellow, to the British Association, and to the Society of Chemical Industry (of whose Scottish branch he was the President at his death). Perhaps the most important of his papers was the one which he contributed five or six years ago to the Institution of Civil Engineers on "Dry-Air Refrigerating Machinery and its Applications." This brought him one of the highest awards in the gift of the Institution. Mr. Coleman was a Fellow of the Chemical Society and of the Institute of Chemistry, and he took a warm interest in the Society of Chemical Industry.

Mr. Coleman suffered from a complication of ailments, the most exhausting of which was chronic asthma. Up till about a week before his death he was able to leave his bedroom, and was always glad to have a visit from his scientific friends and his colleagues in the Philosophical Society and in the Technical College.

Although Mr. Coleman's name is indissolubly associated with a most important invention devised for increasing and cheapening the supply of fresh meat for the home population, and which has accomplished its purpose with the greatest success, one would form but an imperfect notion of his character and life-work if he were regarded merely as an inventor. While the turn of his mind was eminently practical, no one had a greater regard for pure science and for those problems that to most men seem to be only of speculative interest. Even his own great invention was the practical working out of a theoretical conception—the transference of heat from one body to another by mechanical means. In all his scientific work, Mr. Coleman was guided by a sound knowledge of the principles of science, and, in particular, of those great conceptions regarding energy that have had so potent an influence on the progress of physics and chemistry during the present century. His work had nothing of a hap-hazard character, but he clearly saw the problem before him, and he had those rare faculties of insight and of originality that always mark the successful scientific discoverer. No one could converse with him on scientific subjects without being struck by those qualities. A turn of a sentence showed how his mind flashed new light on the problem under discussion, he went quickly to first principles, and he soon saw where there was the likelihood of progress. As an experimentalist he was highly skilful, and he always aimed at simplicity in the construction of apparatus.

Mr. Coleman was a keen lover of truth in all departments of human activity. He thought much and deeply, and in the later months of his life, when the frail body seemed to be worn out by the intensity of the spirit within, his mind was much exercised on questions of religion and philosophy. Although, from a natural timidity, somewhat reserved to strangers, Mr. Coleman had a warm and affectionate nature that unfolded itself to his more intimate friends, and he was in all respects a man of great simplicity and transparency of character. He accomplished much in his comparatively short life as a labourer in science, and not a little of his work is of an enduring character.

J. G. M'KENDRICK.
JOHN MAYER.

REPORTS OF SECTIONS.

SESSION 1888-89.

[Received at Meeting of Society on 1st May, 1889.]

1. Report of Architectural Section.

During the Session eight Meetings have been held. The following is the list of the papers read at the Meetings :—

Monday, November 19, 1888.—Opening Meeting, when Mr. James Thomson, architect, F.R.I.B.A., gave his Address as President. Subject: "A Review of Work done during the past Year."

Monday, December 3, 1888.—Mr. William J. Anderson, architect, read a paper on "Alexander Thomson's Student's Tour in Italy."

Monday, December 17, 1888.—Mr. James Chalmers, architect, read a paper on "Some considerations affecting Unremunerative Property in Glasgow."

Monday, January 21, 1889.—Mr. W. P. Buchan, plumber, read a paper on "How not to do it."

Monday, February 4, 1889.—Mr. Henry Dyer, C.E., read a paper on "The Training of Architects."

Monday, February 18, 1889.—Mr. David Thomson, architect, read a paper on "Development in Architecture."

Monday, March 4, 1889.—Mr. Thomas Gildard, architect, read a paper on "'Tis Fifty Years since."

Monday, March 18, 1889.—Mr. James Howatt, measurer, read a paper on "Mutual Gables."

The thanks of the Section are due to all those gentlemen.

During the Session 16 Associates joined the Section.

The Annual Business Meeting was held on Monday, March 18, 1889, when the following gentlemen were elected to office :—

President—Mr. James Thomson, architect, F.R.I.B.A.

Vice-Presidents—Mr. T. L. Watson, architect, and Mr. William Cairns, plumber.

Treasurer—Mr. James Howatt, measurer, 146 Buchanan Street.

Secretary—Mr. A. Lindsay Miller, architect, 121 West Regent Street.

Members of Council—Mr. Campbell Douglas, architect; Mr. Thomas Gildard, architect; Mr. P. M'Gregor Chalmers, architect; Mr. William Gilfillan, marble cutter; Mr. David MacBean, architect; Mr. Andrew Black, smith; Mr. James Chalmers, architect; Mr. R. A. M'Gilvray, plasterer; Mr. William Howatt, measurer; Mr. Neil C. Duff, measurer.

(Signed) A. LINDSAY MILLER, *Architect*,
Hon. Secy. of Section,
121 WEST REGENT STREET.

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2. REPORT OF THE GEOGRAPHICAL AND ETHNOLOGICAL SECTION.

One paper from the Section was read before the Society this Session. It was by Mr. J. C. Rogers, Vice-Consul of the Republic of Chile, on "The Republic of Chile: its Present Condition and Future Prospects." It was read at the Society's Meeting held on 23rd January, and will be printed in the *Proceedings*. Three other Meetings were held under the arrangement for holding joint Meetings with the Glasgow Branch of the Royal Scottish Geographical Society, at which the following papers were read :—(1) "The Island of Melanesia," by Dr. R. H. Codrington, on 5th February; (2) "Scientific Earth-Knowledge as an Aid to Commerce," by Dr. Hugh R. Mill, on 19th March; and (3) "Samoa," by Dr. G. A. Turner, on 9th April.

Office-Bearers for 1888-89.

President—W. G. Blackie, Ph.D., LL.D., F.R.G.S.

Vice-Presidents — James Stevenson, F.R.G.S.; Sir Michael Connal, Thomas Muir, M.A., LL.D., F.R.S.E.

Secretary and Treasurer—G. A. Turner, M.D., C.M.

Members of Council—Mr. Alex. Scott, Mr. W. Renny Watson, Mr. Robt. Blyth, C.A.; Mr. George Miller, James Christie, A.M., M.D.; Mr. William Ewing, Mr. Nathaniel Dunlop, Mr. Robert Gow, Mr. Jas. Grierson, Mr. Maxwell Hannay, Mr. William Ker, Mr. Jacques Van Raalte.

(Signed) GEO. A. TURNER, M.D.,
Secretary.

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3. REPORT OF THE BIOLOGICAL SECTION.

This Section has held no Meetings of its own during the Session, but a number of Biological papers have been read before General Meetings of the Society.

The President, Professor Cleland, read a paper upon the "Movements of the Joints at the Knuckles and Balls of the Toes."

Mr. Wm. Milne, M.A., B.Sc., F.R.S.E., presented a contribution on "Rotifer as a Parasite and Tube-dweller."

Mr. James Thomson, F.G.S., discussed the question of "Mural Pores in the Genus *Alveolites.*"

Dr. Neil Carmichael exhibited and described Micro-photographs of various Microbes.

(Signed) JOHN YULE MACKAY,
Secretary.

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4. REPORT OF THE MATHEMATICAL AND PHYSICAL SECTION.

At the Annual General Meeting of the Society, held on the 7th November, 1887, the following Office-Bearers were appointed for the Mathematical and Physical Section :—

President—Sir William Thomson, LL.D., F.R.S., &c.

Vice-Presidents—Thomas Muir, M.A., LL.D.; and Professor Robert Grant, LL.D., F.R.S.

Secretary and Treasurer—Magnus Maclean, M.A., F.R.S.E.

Members of Council—Mr. Peter Alexander, M.A.; Professor James Blyth, M.A.; Mr. James T. Bottomley, F.R.S.; Mr. Henry Dyer, M.A., B.Sc.; Professor W. Jack, LL.D.; Professor Andrew Jamieson, F.R.S.E.; Professor James Thomson, F.R.S.; Mr. James Wood, M.A.

The Section held no Meetings of its own during the Session, but at three of the Ordinary Meetings of the Society four papers were contributed on subjects covered by the title of the Section. One of those papers will be printed in the *Proceedings.*

(Signed) MAGNUS MACLEAN.
Secretary,
UNIVERSITY OF GLASGOW.

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5. REPORT OF THE CHEMICAL SECTION.

For the reasons stated in last report, no change has taken place in the constitution of the Section, and no Meetings have been held during the Session.

The Section may now be regarded as existing chiefly for the purpose of administering, in conjunction with the Philosophical Society, the "Graham Medal and Lecture Fund."

It may be added that steps are being taken to secure an eminent cultivator of science as "Graham Lecturer" for next Session, as well as to arrange for the contribution of papers for the "Graham Medal."

(Signed) JOHN TATLOCK,
Secretary of Section.

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6. REPORT OF THE SANITARY AND SOCIAL ECONOMY SECTION.

A Meeting of the Section was held on 7th November, 1888, at which the following Office-Bearers were elected:—

President—John Honeyman, F.R.I.B.A., 140 Bath Street.

Vice-Presidents—James Christie, M.D., 2 Great Kelvin Terrace; D. G. Hoey, 8 Gordon Street.

Members of Council—John Young, 234 Parliamentary Road; James Chalmers, I.A., 101 St. Vincent Street; Peter Fyfe, 1 Montrose Street; Walter Arrol, 16 Dixon Street; Alexander Scott, 2 Lawrence Place; W. P. Buchan, 21 Renfrew Street; J. Cleland Burns, 30 Jamaica Street; H. K. Bromhead, A.R.I.B.A., 245 St. Vincent Street; D. M. Alexander, Wellington Street; Councillor Crawford, 84 Miller Street; W. R. W. Smith, 6 South Hanover Street; Ebenezer Duncan, M.D., 4 Royal Crescent, Crosshill.

It was agreed to recommend that Papers by the following gentlemen be read before the Society during the Session :—

(1) Paper by Mr. John Honeyman, F.R.I.B.A.; (2) Joint-Paper by Messrs. Jas. Chalmers and William Key; (3) Paper by Mr. D. G. Hoey.

The following Papers were read before the Society during the Session :—

(1) Mr. John Honeyman, Presidential Address; (2) Messrs. Chalmers and Key, Joint-Paper on "Cremation"; (3) Mr. D. G. Hoey on "Ventilation"; (4) Mr. John Honeyman on "Safe House Drainage without Ventilation."

(Signed) W. R. M. Church, C.A.,
Hon. Secretary,
75 St. George's Place.

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7. Report of the Economic Science Section.

President—Charles Gairdner, LL.D.

Vice-Presidents—Wm. Smart, M.A., and Alexander Cross.

Secretary and Treasurer—Walter W. Blackie, B.Sc.

Members of Council—Wm. Ewing, Charles Ker, M.A., C.A.; John Mann, jun., M.A., C.A.; George Barclay, Charles E. Beckett, M.A., LL.B.; James Marr, James Mavor, and George Younger.

The following retired from the Council at the beginning of the Session :—

Stephen Mason, James Muir, and George Handasyde Dick.

The following Meetings of Section were held during the Session :—

Monday, November 12, 1888—Paper on the "Economic Importance of Scientific Agriculture," by Mr. R. Hedger Wallace, Lecturer on Agriculture.

Monday, December 10, 1888—Paper on "Land Ownership in Scotland," by Mr. Robert T. Younger, M.A., LL.B., Advocate.

Monday, January 14, 1889—Paper on "The Revival of Rural Industry," by Mr. George Eyre-Todd.

Tuesday, January 19, 1889—Paper entitled, "An Examination into the Report of the Commission on Gold and Silver, with remarks on Bi-metallism," by Mr. Chas. Gairdner, LL.D., President of the Section.

Monday, February 25, 1889—Paper entitled, "Constructive Economics, their Nature and Scope," by Mr. W. L. Rees, of New Zealand, Barrister.

Thursday, March 7, 1889—An adjourned Meeting for the discussion of Mr. Gairdner's Paper read on Tuesday, January 19.

Tuesday, March 12, 1889—Paper on "State Purchase of Land in Ireland," by Mr. Mark Davidson, M.A., LL.B., Advocate.

The Council expected that Mr. Robert Giffen, of the Board of Trade, would read a paper before the Section or the Society during the course of the Session, but Mr. Giffen's official duties unfortunately prevented this.

(Signed) WALTER W. BLACKIE,
Hon. Secy. of Section.

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8. REPORT OF THE PHILOLOGICAL SCIENCE SECTION.

At the close of the first Session of this Section the Council have to report a highly gratifying measure of success. The formation of the Section was the outcome of a paper read by Dr. Colville before the Society on "The Gothic Version of the Gospels." Towards the end of Session 1887-8, the Section having been duly constituted, the following Office-Bearers were elected :—

President—Professor Jebb, LL.D.

Vice-Presidents—Prof. Robertson, D.D.; Prof. Skeat, M.A.

Secretary and Treasurer—Dr. Colville.

Members of Council—David Ross, LL.D.; Jas. Macdonald, LL.D.; F. J. Amours, B.A.; W. Thomson, B.A.; Justus Widmer, Jas. Morison, Wm. Bathgate, M.A., H.M.I.S.; D. G. Hoey, C.A.

The following Papers were read before the Section :—

(1) Comparative Rhythm," by Mr. W. Thomson, B.A.; (2) "Proverbs in connection with Language," by Mons. H. Rey, B.A.; (3) "Some Alliterative Scottish Poetry," by Mons. F. J. Amours, B.A. As a contribution from the Section, Dr. Colville read a paper before the Society on "Primitive Aryan Civilisation." The President, Prof. Jebb, was unavoidably compelled to delay his Presidential Address till late in the Session. His subject was on "Present Tendencies in Classical Studies." This address, which was delivered before the Society, will be printed in the *Proceedings*.

(Signed) JAS. COLVILLE, M.A., D.Sc.,

Secretary of Section,

15 NEWTON PLACE.

Report of Delegate to the British Association—Bath, 1888.

[Received at Meeting of Society, 1st May, 1889.]

Having been appointed Delegate to the Corresponding Societies' Committee of the British Association, I beg to report:—

The Committee held two Conferences, both of which I attended—Professor W. Boyd Dawkins, F.R.S., Chairman.

First Conference.

Prehistoric Monuments Committee.—Mr. J. W. Davis reported that the Committee had been carrying on the work for the past year, and asked for its reappointment. A very extensive and elaborate report on prehistoric remains and "finds" is given in the British Association Report for 1888, pp. 289-315. Dr. Garson pointed out that local societies could do good service by inducing proprietors to communicate with General Pitt-Rivers, Inspector of Ancient Monuments, with the view of placing these remains under Government protection. Dr. Muirhead mentioned that there was a Bill before Parliament with the object of appointing local officers, to whom application could be made when by-paths or other public places were being encroached on, and suggested that possibly a clause might be got introduced to include the Ancient Monuments under the same Act; but Sir John Lubbock, M.P., and General Pitt-Rivers said that there was not the slightest probability of that Bill becoming law.

Earth Tremors.—Professor Lebour brought this subject before the Conference, and stated that the North of England Institute of Mining and Mechanical Engineers had for two years carried on a series of seismoscopic observations at Marsden, in the County of Durham. He said a good seismoscope could be had for £2, a seismograph for £14, and the cost of the keep would not be great. Professor Ewing stated that from recent observations it appeared that tremors would be found if they were tested for with sufficient delicacy.

Second Conference.

Dr. H. R. Mill, as representing a Committee on *Temperature, Variations in Lakes, Rivers, and Estuaries*, stated that the question had not been fully wrought out, but that a few observations made showed relations of a very interesting kind. He proposed that societies situated near rivers and estuaries should appoint one or more persons to observe the temperature daily or weekly. Mr. G. J. Symons, F.R.S., pointed out the necessity for having a well-considered scheme and perfectly reliable thermometers, without which no observations would be of any value.

Erratic Blocks Committee.—Mr. De Rance said this Committee wanted information as to the position, size, and character of boulders of foreign origin that may occur in drift areas.

Sea-Coast Erosion Committee.—Mr. Topley stated that a printed form of inquiry could be procured from him at the Geological Survey Office, Jermyn Street, London.

Life-Histories of Plants.—A communication was read from Prof. Bayley Balfour, in which he urged the importance of encouraging members of societies to study the life-histories of indigenous plants in their entirety—that is to say, from the stage of embryo in the seed up to the production of fruit and seed again. Any one who will take up this line of study will derive great pleasure from it, and will be able to add a great deal to our stock of knowledge. The foregoing was the principal business transacted at the Meetings of Conference.

(Signed) HENRY MUIRHEAD.

PROPOSED CAPITALISING OF LIFE MEMBERS' SUBSCRIPTIONS.

REPORT BY COMMITTEE OF COUNCIL APPOINTED 30TH JANUARY, 1889, TO CONSIDER THE SUBJECT OF CAPITALISING THE INCOME DERIVED FROM LIFE MEMBERSHIP COMPOSITION UNDER ARTICLE V. OF THE SOCIETY'S ARTICLES OF ASSOCIATION.

The Committee having examined the Analysis of Receipts and Expenditure, prepared by the Treasurer, for the period of the Society's occupation of the new Buildings—namely, the seven years ending 31st October, 1888, and having fully considered the fluctuations and averages of each class of Income and Disbursement, find as follows :—

	£	s.	d.
Sums paid direct to first cost of Buildings, 207 Bath Street, and furnishings: 1881-2, £145 1s. 11d.; 1882-3, £47 6s. 2½d., ...	£192	8	1½
Sums paid in liquidation of floating debt, previously incurred for Buildings (not reckoning Interest on such debt), namely, 1883-4, £200; 1884-5, £100; 1886-7, £200, ...	500	0	0
Balance due Treasurer at beginning of period (1st November, 1881), £109 9s. 11d.; balance in Treasurer's hands at close of period (31st October, 1888), £20 4s. 5d.; these sums showing a difference in favour of the Society amounting to	129	14	4
Improvement in Society's position in seven years,	£822	2	5½
Total amount received for Life Compositions during that period, from 62 Members at £10 10s. each, ...	651	0	0
Difference contributed from ordinary Revenue to this improvement, ...	£171	2	5½

Thus it will be seen that not only has the whole amount received for Life Membership been really capitalised, by being applied to the reduction of debt, but that the further sum of £171 2s. 5½d. from ordinary Revenue has been devoted to the same purpose, and the Committee recommend that a similar policy be, as far as practicable, pursued in the future.

The Life Compositions received in the years prior to the seven years before referred to—being 39 members, £409 10s.—were also applied to the payment of the Society's half of the cost of the new buildings and furniture.

The Committee have given attention to each item of expenditure in the "Analysis," and cannot point to any one which can be singled out for reduction. They find the item of joint expenses of management of the rooms to be remarkably uniform, after setting-off the revenue from lettings. They hope the latter may be increased, and think that an effort might be made, jointly, of course, with the co-proprietors, the Institution of Engineers, in that direction.

It appears to the Committee that, as the subject of capitalising the income from life members' payments, really resolves itself into the question of keeping the ordinary expenditure within the ordinary income, the desire of the Society may be met by exercising all possible care in the expenditure on the one hand, and on the other hand by influencing the accession of new members.

On the former of these branches—the expenditure—they would suggest that the purchasing of new books be delayed far enough into the session to enable an estimate to be made of the available funds, and that in ordering new periodicals special consideration be given to the fact that these practically become annual charges. Further, that the Council, in considering the question of printing papers read before the Society and its Sections, should bear in mind the possibility of economising, by giving merely an abstract, when the nature of the paper admits of this without doing an injustice to the author.

On the other branch—the accession of new members—they may point out that the annual subscriptions of ordinary members show a falling-off in the seven years under review, namely—from £694 1s. in 1881-2, to £596 8s. in 1887-8, which is rather more than is accounted for by the transfer of names from the ordinary to life membership footing.

Reported by

THOMAS MUIR.
HENRY DYER.
ALEX. SCOTT.
JOHN ROBERTSON.
JOHN MAYER, *Secretary.*
JNO. MANN, *Treasurer and Convener.*

GLASGOW, *6th February, 1889.*

MINUTES OF SESSION.

7th November, 1888.

The Philosophical Society of Glasgow held its First Meeting for Session 1888-89 on the evening of Wednesday, 7th November, 1888, at eight o'clock, in the Society's Rooms, 207 Bath Street—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of Meeting held on 2nd May, 1888, which had been printed in Vol. XIX. of the Society's *Proceedings*, now in the hands of the members, were held as read, were approved of, and signed by the Chairman.

2. Dr. Russell delivered the Opening Address "On the 'Ticketed Houses' of Glasgow, with an Interrogation of the Facts for Evidence towards the Amelioration of the Lives of their Occupants." At the close he was awarded a hearty vote of thanks, on the motion of Dr. Muir, seconded by Mr. Honeyman.

3. Mr. William Lang, jun., F.C.S., President of the Glasgow Photographic Association, read a paper on "The Eastman Stripping Film and Roller Slide: A Recent Development in Scientific Photography." Some remarks were made on the subject by Mr. Alexander Scott, Mr. John Brown, and Mr. J. Craig Annan; and Mr. Lang was thanked for his communication, and for the practical demonstration which accompanied it.

4. On the motion of the Chairman, Messrs. Alexander Scott and Robert Gow were appointed to audit the Treasurer's Accounts for the year 1887-88.

5. The President announced that the following Candidates for admission into the Society had been elected:—Mr. Alexander Somerville, B.Sc., F.L.S., 34 Granby terrace, Hillhead; Dr. John A. Kennedy, Ellangowan, Bearsden; Dr. Thomas F. Gilmour, 231 Paisley Road, West; Mr. A. R. Mees, manager, Netherlands Consulate, 136 West Regent Street; M. Jules Coste, French Consul, 131 West Regent Street; Dr. David Ross, M.A., B.Sc., Principal, E.C. Training College; Councillor William

Bilsland, 3 Lynedoch Place; and Mr. J. Craig Annan, photographer, 153 Sauchiehall Street.

21st November, 1888.

The Annual General Meeting of the Philosophical Society of Glasgow was held in the Society's Rooms, 207 Bath Street, on the evening of Wednesday, 21st November, at eight o'clock—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the First Ordinary General Meeting for Session 1888-89, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. Alexander Somerville, B.Sc., F.L.S., Dr. John A. Kennedy, Dr. Thomas F. Gilmour, Mr. A. R. Mees, M. Jules Coste, Dr. David Ross, M.A., B.Sc., Councillor William Bilsland, and Mr. J. Craig Annan, were admitted to the Membership of the Society.

3. The Annual Report by the Council on the State of the Society having been printed in the Billet convening the Meeting, was held as read, and its adoption was moved from the Chair, and agreed to by the Meeting. The Report is subjoined:—

REPORT ON THE STATE OF THE SOCIETY BY THE COUNCIL FOR SESSION 1887-88.

I. *Meetings.*—The Session 1887-88 opened on 2nd November, 1887, and closed on 2nd May, 1888; and during that period fourteen meetings were held, one of them taking place in the Natural Philosophy Class-Room at the University, on 8th February, on which occasion four communications were made to the Society by Dr. M'Kendrick, and one by Sir William Thomson, all of which were very fully illustrated by experimental demonstrations. In all, twenty-seven papers were communicated to the Society, of which nineteen are published in full or in abstract in the new volume of the *Proceedings.* Two other meetings of the Society were held conjointly with the Scottish Geographical Society, and at these meetings two papers were read.

II. *Membership.*—The number of Ordinary Members on the Roll at the beginning of Session 1887-88 was 642. During the Session 49 new Members were elected, making 691. Of these 28 have resigned, 13 have died, 7 have left Glasgow and their names have been placed on the Suspense List, and 1 has been struck off the Roll for non-payment of subscriptions—leaving on the Roll at the beginning of the present Session 642 Members, being neither increase nor decrease. Of the 49 New Members, 5 became Life Members. There are now 95 Life Members. One vacancy exists in the list of Honorary Members. There are at present 19 Honorary Members, of whom 7 are Continental, 4 are American or Colonial, and 8 are British. The number of Corresponding Members is 10. The Membership of the Society, then, is as follows:—Honorary Members, 19; Corresponding Members, 10; Ordinary Members, 642; or a total of 671.

III. *Sections.*—(1) Eight meetings of the *Architectural Section* were held during the Session, at which nine papers were read, chiefly on professional subjects. Three of them, at the request of the Council of the Section, have been published in the *Proceedings.*

(2) No meetings of the *Chemical Section* were held during the Session, but the Associates were invited to the periodical meetings of the Glasgow and Scottish Branch of the Society of Chemical Industry, which were also notified to the members of the Society generally.

(3) Three communications were made to the Society's General Meetings in connection with the *Sanitary and Social Economy Section*, but no separate meetings of the Section were held. The papers all appear in the *Proceedings* —one of them in abstract.

(4) No separate meetings of the *Geographical and Ethnological Section* were held in the course of the Session. Through the agency of the Section two papers were read before the Society. One of them is published in the *Proceedings.*

(5) No meetings of the *Biological Section* were held during the Session, but several communications connected with biological studies were made to the Society, two of which are published in the *Proceedings.*

(6) In addition to Sir William Thomson's paper, already referred to, three papers were contributed from the *Mathematical and Physical Section.* They also appear in the *Proceedings.*

(7) Eleven meetings of the *Economic Science Section* were held during the Session, at which ten papers were read. One communication was sent from the Section to be read before the Society. That and other three papers are published in the *Proceedings.*

(8) The *Philological Section*, which was referred to in last report, has now been organised, and in the course of this Session it will be formally inaugurated by an Address from the President, Professor Jebb, LL.D.

IV. *Proceedings.*—The Council congratulate the Society on the publication of Vol. XIX. of the *Proceedings*, which is now in the hands of the Members. Of the twenty-six papers or abstracts which it contains, one was communicated to the Society in Session 1885-86, but its publication was deferred at the request of the author. The contents of the volume, which are of a very varied and comprehensive character, cannot fail to maintain the high standing of the Society both at home and abroad. The various papers are illustrated by means of thirty-six figures distributed through the text, and by eleven plates, two of which are coloured, and one map.

V. *Index to Proceedings.*—The General Index to the *Proceedings*, the preparation of which was referred to in last report, is making progress in the hands of the Special Committee appointed for the purpose, and consisting of Professors Ferguson and Mills, and Mr. John Robertson, Librarian. As previously mentioned, it is intended to make this Index embrace twenty volumes of *Proceedings*, one of which is still to be published.

VI. *Funds of the Glasgow Science Lectures Association.*—During last Session the Society received in trust the sum of £252 10s., being the residue of the Funds of the Glasgow Science Lectures Association, which has ceased to have a separate existence. The legal deed of transference has been engrossed in the Society's Minute Book ; and in due course the interest arising from the money invested will be periodically used by the Council of the Society in doing such work as the Science Lectures Association was created to carry on.

VII. *Finance.*—The Treasurer's Statement shows—from there having been a balance due to him at the beginning of the year, since paid off, of £18 12s. 4½d., and a balance remaining on hand at the close of £20 4s. 5d. —that the Funds have improved to the extent of these two sums, or £38 16s. 9½d. ; and it is believed that no accounts are owing by the Society.

By order and on behalf of the Council.

(Signed) JOHN MAYER,
Secretary.

4. The Treasurer's audited Statement of the Funds of the Society, which had also been printed in the Billet, was next submitted by the Chairman, and its adoption moved. Mr. David Mackinlay made some remarks on the desirability of having the Subscriptions of Life Members capitalised, in reply to which the Chairman stated that the matter referred to had already received some attention from the Council, and that Mr. Mackinlay's suggestion would be brought before an early meeting of the Council.* The motion was unanimously agreed to. The Abstract of Treasurer's Account of the Graham Medal and Lecture Fund was also submitted and approved of. Both of these Financial Statements are subjoined :—

(See Financial Statements, pp. 348-350.)

* A Council Report on this subject will be found at p. 341.

5. Mr. John Robertson, on behalf of the Library Committee, submitted the Report on the State of the Library. Its adoption was agreed to, and, on the motion of Mr. Robertson, the thanks of the Society were awarded to the donors of Books to the Library during the year. The Report was as follows:—

REPORT OF THE LIBRARY COMMITTEE.

The Library Committee have pleasure in reporting that the Library has been taken advantage of by the members to a larger extent during the past session than in any previous one. One thousand and forty-four volumes were issued to 698 readers.

During the year 52 volumes and 43 pamphlets were presented to the Library, and 60 volumes and 9 parts of works were added by purchase.

The periodicals at present received number 101, of which 64 are bought. They form altogether 146 volumes annually. The total additions to the Library for the year amount to 258 volumes, 9 parts, and 43 pamphlets.

Exchanges are effected with 155 Societies, Public Departments, &c.

In Volume XIX. of the *Proceedings*, pp. 419-427, will be found a list of the additions to the Library both by presentation and by purchase, the names of the Societies with which exchanges are made, and the titles of all the periodicals received by the Society.

During the year 93 volumes were bound. The number of volumes now in the Library is estimated at 10,370.

JOHN ROBERTSON, LIBRARIAN,
Convener.

6. On the motion of the Chairman, the best thanks of the Society were awarded to the Treasurer and the Librarian for their services during the past year.

7. The Society then proceeded to the election of Office-Bearers:—

(1) For the vacant Vice-Presidentship caused by the retiral by rotation of Dr. Morton, Dr. M'Kendrick, on behalf of the Council, moved the election of Mr. W. Renny Watson, which was agreed to.

(2) The Chairman moved the re-election of Mr. Robertson as Librarian, Mr. Mann as Treasurer, and Mr. Mayer as Secretary, which was also agreed to.

(3) Four vacancies in the Council were filled by the election of Mr. Wallace Fairweather, C.E., who had only served one year; Mr. William Smart, M.A.; Mr. Alexander Scott, and Mr. Robert Gow—on the motion of Mr. Dyer, seconded by Dr. M'Kendrick. The Members of Council who retired by rotation, in addition to Mr. Fairweather, were—Professor Dittmar, Mr. W. Renny Watson, and Mr. J. L. Mitchell.

Dr. ABSTRACT OF TREASURER'S

To SUBSCRIPTIONS to 31st October, 1888—			
Entry-money from 49 New Members, at 21s.,		£51 9 0	
Annual Dues from 1 Member for 1884-85, at 21s., . .	£1 1 0		
Annual Dues from 2 Members for 1885-86, at 21s., . .	2 2 0		
Annual Dues from 6 Members for 1886-87, at 21s., . .	6 6 0		
Annual Dues from 515 Ordinary Members for 1887-88, at 21s.,	540 15 0		
Annual Dues from 44 New Members for 1887-88, at 21s.,	46 4 0		
		596 8 0	
Life Subscription from 5 New Members, at £10 10s., ...		52 10 0	
			£700 7 0
,, GENERAL RECEIPTS—			
,, Corporation of Glasgow, Interest on "Exhibition Fund," £451 17s. at 4½ °/ₒ, for year to Whitsunday, 1888—less Income Tax, ...		£19 14 10	
,, Bank Interest, ...		1 7 2	
,, *Proceedings, Catalogues*, &c., sold, . .		4 19 3	
			26 1 3
,, ARCHITECTURAL SECTION—			
82 Associates' fees for 1887-88, at 5s., .		. .	20 10 0
,, CHEMICAL SECTION—			
5 Associates' fees for 1887-88, at 5s., .		. .	1 5 0
,, GEOGRAPHICAL AND ETHNOLOGICAL SECTION—			
1 Associate's fee for 1885-86, at 5s., .		£0 5 0	
5 Do. for 1886-87, at 5s., .		1 5 0	
29 Do. for 1887-88, at 5s., .		7 5 0	
1 Do. for 1888-89, at 5s., .		0 5 0	
1 Do. for 1889-90, at 5s., .		0 5 0	
			9 5 0
,, MATHEMATICAL AND PHYSICAL SECTION—			
11 Associates' fees for 1887-88, at 5s., .		. .	2 15 0
,, ECONOMIC SCIENCE SECTION—			
2 Associates' fees for 1886-87, at 5s., .		£0 10 0	
52 Do. for 1887-88, at 5s., .		13 0 0	
			13 10 0
			£773 13 3

Memo. by Treasurer.—The Amount invested by the Society in the Bath Street Joint Buildings up to 31st October, 1888, is . £3,547 8 1¼

whereof, Paid from Society's Funds, £2,047 8 1¼

Do. Society's half of £3,000 Bond, . 1,500 0 0

£3,547 8 1¼

J. M.

ACCOUNT—SESSION 1887-88. **Cr.**

	£	s.	d.	£	s.	d.
By Balance due to Treasurer from last year,				£18	12	4½
,, General Expenditure to 31st October, 1888—						
Salary to Secretary,	£75	0	0			
Allowance for Treasurer's Clerks,	15	0	0			
Rent for Joint-Lectures with Scottish Geographical Society,	1	0	0			
Expenses at Lectures,	0	3	6			
				91	3	6
New Books, Periodicals, and Foreign Periodicals,	£139	14	1			
Bookbinding,	10	7	0			
Printing Circulars, *Proceedings*, &c.,	199	0	0			
Lithographs and Woodcuts for *Proceedings*, &c.,	38	2	2			
Postage and delivery of Circulars, Letters, and Parcels,	44	0	9			
Stationery, &c.,	4	11	3			
				435	15	3
Fire Insurance on Library for £5,400,	£6	1	3			
Postages, &c. — per Secretary, £4; per Treasurer, £2 14s. 11½d.,	6	14	11½			
				12	16	2½
Joint Expenses of Rooms—Society's half of £383 19s. 11½d., being Interest on Bond, Insurance, Taxes, Cleaning, Lighting, and Heating; Salaries of Sub-Librarian and Assistant—less half of £56 5s. Revenue from Letting,				163	17	6
,, Subscriptions to Societies—						
Ray Society, 1888,	£1	1	0			
Palæontographical Society, 1888,	1	1	0			
				2	2	0
,, Architectural Section— Expenses per Treasurer of Section,				9	14	0
,, Mathematical and Physical Section— Expenses per Treasurer of Section,				0	1	2
,, Geographical and Ethnological Section— Expenses per Treasurer of Section,				7	8	6
,, Sanitary and Social Economy Section— Expenses per Treasurer of Section,				0	12	6
,, Economic Science Section— Expenses per Secretary of Section,				11	5	10
,, Balance in Treasurer's hands,				20	4	5
				£773	13	3

Glasgow, *12th November, 1888*.—We, the Auditors appointed by the Society to examine the Treasurer's Accounts for the year 1887-88, have examined the same, of which the above is an Abstract, and have found them correct, the Balance in Treasurer's hands at 31st October last being Twenty Pounds Four Shillings and Fivepence.

(Signed) ROBERT GOW.
ALEX. SCOTT.

GRAHAM MEDAL AND LECTURE FUND.

ABSTRACT OF TREASURER'S ACCOUNT—SESSION 1887-88.

Dr.

CAPITAL AT 1ST NOVEMBER, 1887—		
Glasgow and South-Western Railway Co. 4 % Preference Stock in name of the Philosophical Society, in Trust,	£250 0 0	
Value of Die at H.M. Mint, - -	18 18 0	
		£268 18 0
Cash in Union Bank, - - - -	£9 1 3	
Cash in Treasurer's hands, - - -	0 10 8	
		9 11 11
REVENUE—		
Dividend, April, 1888, less Tax, - -	£4 17 1	
,, Oct. ,, ,, ,, - -	4 17 4	
Interest from Bank, - - - -	0 4 6	
		9 18 11
		£288 8 10

Cr.

CAPITAL AT 31ST OCT., 1888—		
Investment, - - - - - -	£250 0 0	
Die, - - - - - - - -	18 18 0	
		£268 18 0
Cash in Union Bank, - - - - -	£19 0 2	
Cash in Treasurer's hands, - - -	0 10 8	
		19 10 10
		£288 8 10

WILLIAM WALLACE, *Treasurer.*

(4) Various Office-Bearers of the Geographical and Ethnological Section were appointed, according to resolution of Society of 11th April, 1883; and of the Chemical, Biological, Sanitary and Social Economy, Mathematical and Physical, and Economic Science Sections, in accordance with resolutions of Society, of 18th November, 1885, and 2nd February, 1887. And the list of Office-Bearers of the Philological Section, as agreed to by the Society on 4th April, 1888, was re-affirmed.

8. At the close of the business proper to the Annual Meeting, the President, on behalf of the Council, submitted the following motion in regard to the late Dr. William Wallace, whose death took place on 5th November current:—"That in remembrance of the services rendered to this Society by the late Dr. William Wallace, during a long Membership, and especially while he occupied the Presidential Chair, we now put on record our regret at his decease, and our sense of the loss the Society thereby sustains; and we further resolve that an extract of this Minute be forwarded to Mrs. Wallace, with an expression of our deep sympathy with her and her family."

9. Dr. James Colville, M.A., then read a Paper on "Civilisation among our Early Aryan Ancestors: an Introduction to Comparative Philology." (A communication from the Philological Section.) On the motion of the President, the thanks of the Society were awarded to Dr. Colville for his paper. Subsequently some remarks were made on the subject of the paper by Rev. Professor Robertson and Dr. David Ross.

10. The President announced that the following gentlemen had been elected to the Membership of the Society:—Mr. H. Matheson Brown, 1 St. James's Place, Hillhead; and Mr. John Hogg, writer, 113 West Regent Street.

5th December, 1888.

The Second Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 5th December, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Annual General Meeting, held on 21st November, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. H. Matheson Brown, 1 St. James's Place, Hillhead, and Mr. John Hogg, writer, 113 West Regent Street, were admitted to the Membership of the Society.

3. Mr. John Honeyman, F.R.I.B.A., as President of the Sanitary and Social Economy Section, delivered his opening address, his subject being "Sanitary and Social Problems." The Chairman made a few remarks upon the address, and, on his motion, the thanks of the Society were awarded to Mr. Honeyman.

4. Mr. A. Lindsay Miller, Secretary of the Architectural Section, read a Memoir of the late Mr. James Sellars, architect, which he had prepared at the request of the Council. Remarks were made on the subject by Mr. David Thomson and the Chairman, and, on the motion of the former, Mr. Miller was awarded the thanks of the Society.

5. Mr. James T. Bottomley, M.A., F.R.S., showed some interesting experiments on Recalescence of Iron, and gave a brief explanation of the phenomenon. Professor Blyth and other Members briefly spoke on the subject, and Mr. Bottomley was cordially thanked for his communication.

6. The Chairman announced that the following Candidates had been elected Members of the Society:—Dr. Charles Annandale, Editor of various Dictionaries, &c., 86 Dixon Avenue, Crosshill; Dr. James Kerr Love, 4 Matilda Place, Strathbungo; Mr. William Thomson, B.A., Linden, Bearsden; Mr. F. J. Amours, B.A., French Master, High School.

7. The Chairman stated that the James Watt Anniversary Dinner, held under the joint auspices of the Institution of Engineers and Shipbuilders in Scotland and the Philosophical Society of Glasgow, would take place next month. As representing the Society in the Arrangements Committee, he moved the election of the President, Mr. Dyer, Mr. Mann, Mr. Fairweather, and Mr. Mayer. The motion was agreed to.

19th December, 1888.

The Third Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the

Society, 207 Bath Street, on Wednesday, 19th December, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Second Ordinary Meeting, held on 5th December, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Dr. Charles Annandale, Editor of various Dictionaries, &c., 86 Dixon Avenue, Crosshill; Dr. James Kerr Love, Matilda Place, Strathbungo; Mr. William Thomson, B.A., Linden, Bearsden; and Mr. F. J. Amours, B.A., French Master, High School, were admitted to the Membership of the Society.

3. The President intimated the death of Mr. J. J. Coleman, Senior Vice-President of the Society, which had occurred on the preceding day, and referred to his valuable communications to the Society, and his important invention, the Bell-Coleman Dry-Air Refrigerating Machine.

4. Professor Cleland, M.D., F.R.S., communicated to the Society "A Description of the Movements of the Joints at the Knuckles and at the Balls of the Toes," for which, on the motion of Dr. Henry E. Clark, he was awarded the thanks of the meeting.

5. Mr William Milne, M.A., B.Sc., F.R.S.E. read a short paper on "Rotifer as a Parasite and Tube-Dweller, for which he received the thanks of the Society.

6. A paper was read by Mr. James Thomson, F.G.S., on "The Detection of Mural Pores in the Genus *Alveolites*." On the motion of the Chairman, Mr. Thomson was thanked for his communication.

(These Papers were all from the Biological Section of the Society.)

7. The Chairman announced that the following Candidates for Membership of the Society had been unanimously elected:—Professor Richard C. Jebb, M.A., L.L.D., University of Glasgow; and Mr. Walker Weir, C.A., Barskiven, Paisley.

9th January, 1889.

The Fourth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the

Society, 207 Bath Street, on Wednesday, 9th January, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Third Ordinary Meeting, held on 5th December, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Professor Richard C. Jebb, M.A., LL.D., University of Glasgow, and Mr. Walter Weir, C.A., Barskiven, Paisley, were admitted to the Membership of the Society.

3. The Secretary read a Biographical Notice of the late Dr. William Wallace, Past-President of the Society, which he had prepared at the request of the Council. On the motion of the President, he was awarded the thanks of the Society for his communication.

4. Mr. James Chalmers, I.A., architect, read a joint paper by himself and Mr. William Key, engineer and manager, Tradeston Gas-Works, on "A Scheme of Cremation suited to the requirements of Glasgow," which was followed by a description of a Crematory Furnace which had been designed by Mr. Key. A discussion followed, in which the speakers were the Chairman, Mr. W. Renny Watson, Dr. Eben. Duncan, Prof. Jamieson, Mr. Alexander Whitelaw, Mr. W. R. W. Smith, and Mr. D. M. Nelson. The authors replied, and were awarded a vote of thanks for their communications.

5. The Chairman announced that the following Candidates for Membership of the Society had been unanimously elected:—As Ordinary Members—Mr. William Horton, gunmaker, Birchfield, Mount Florida; and Mr. James Mollison, engineer surveyor to Lloyd's Register, 36 Oswald Street. As an Honorary Member—Professor F. Max Müller, M.A., Oxford.

23rd January, 1889.

The Fifth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 23rd January, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Fourth Ordinary Meeting, held on 9th January, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. William Horton, gunmaker, Birchfield, Mount Florida, and Mr. James Mollison, engineer surveyor to Lloyd's Register, 36 Oswald Street, were admitted to the Membership of the Society.

3. The President read the following letter which the Secretary had received from Professor Max Müller in reference to his election as an Honorary Member of the Society:—

7 Norham Gardens,
Dear Sir, Oxford, *17th January*, 1889.

It is very kind of the Members of the Philosophical Society of Glasgow to have thought of me as worthy of a place among their twenty Honorary Fellows.

I shall never forget the extreme kindness with which I was received while lately lecturing at Glasgow, and I shall value this new proof of friendly sympathy all the more highly as coming from those whom I have learnt to know and to value during my stay in Scotland.

Please to convey to the Members of Council my sincere thanks for the very high honour which they have conferred on me.

I am, Dear Sir,
Yours faithfully,
John Mayer, Esq. F. MAX MÜLLER.

4. Mr. John C. Rogers, Chilian Vice-Consul, Glasgow, read a paper on "The Republic of Chilé: its Present Condition and Future Prospects," being a communication from the Geographical and Ethnological Section. On the motion of Dr. W. G. Blackie, President of the Section, Mr. Rogers was awarded a vote of thanks for his interesting communication.

5. Mr. W. Anderson Smith, Member of the Scottish Fishery Board, read a paper on "Fisheries in relation to general Civilisation and Progress," for which he was awarded the best thanks of the Society.

6. The Chairman announced that the following Candidates for Membership of the Society had been unanimously elected:—M. Hector Rey, B.L., B.Sc. (France), French Master, 27 Kersland Terrace, Hillhead; Mr. G. F. H. Brown, portioner, 3 South Apsley Place; and Mr. Thomas Taylor, ivory turner, &c., 60 Montrose Street.

6th February, 1889.

The Sixth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 6th February, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Fifth Ordinary Meeting, held on 23rd January, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. M. Hector Rey, B.L., B.Sc. (France), French Master, 27 Kersland Terrace, Hillhead; Mr. G. F. H. Brown, portioner, 3 South Apsley Place; and Mr. Thomas Taylor, ivory turner, 60 Montrose Street, were admitted to the Membership of the Society.

3. Mr. C. M. Aikman, M.A. B.Sc., F.R.S.E., Lecturer on Agricultural Chemistry in the Glasgow and West of Scotland Technical College, read a paper on "Agricultural Education in this Country and in Germany," for which he received the thanks of the Society. A discussion took place, in which the speakers were Mr. Dyer, Mr. W. R. W. Smith, Mr. Younger, and Mr. John Young, Secretary of the Technical College.

4. Mr. D. Sinclair, Engineer, National Telephone Company, read a paper on "Multiplex Telephony on Long Lines." Remarks were made on the subject by Mr. J. T. Bottomley, F.R.S., Mr. A. Scott, and Mr. J. D. F. Andrews, and Mr. Sinclair was awarded the thanks of the Society for his communication.

5. The Chairman announced that the following Candidate for Membership of the Society had been elected:—Mr. William Alexander, blockmaker, Helen Street, Govan.

20th February, 1889.

The Seventh Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 20th February, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Sixth Ordinary Meeting, held on 6th February, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. William Alexander, blockmaker, Helen Street, Govan, was admitted to the Membership of the Society.

3. Professor R. C. Jebb, M.A., LL.D., delivered his Inaugural Address as President of the Philological Section, his subject being "Present Tendencies in Classical Studies." At the close of his Address he was awarded a hearty vote of thanks on the motion of Dr. Colville, seconded by Dr. David Ross.

4. Mr. A. Tanakadate, B.Sc. (Japan), Physical Laboratory, University of Glasgow, read a paper on "Electro-Magnetic Method of Measuring the Magnetic Constants of the Earth's Field." Remarks were made on the subject of the paper by Mr. Dyer, Mr. J. T. Bottomley, and Professor Blyth; and the author was awarded the best thanks of the Society for his paper.

5. The Chairman announced that the following Candidate for Membership of the Society had been elected:—Mr. William M'Whirter, electrical engineer, Faraday Electrical Works, Govan.

6th March, 1889.

The Eighth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 6th March, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Seventh Ordinary Meeting, held on 20th February, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. William M'Whirter, electrical engineer, Faraday Electrical Works, Govan, was admitted to the Membership of the Society.

3. Mr. D. G. Hoey, Vice-President of the Sanitary Section, read a paper on "The Science of Ventilation as applied to Inhabited Interiors;" and Mr. John Honeyman, F.R.I.B.A., President of the Section, read a short paper on "Safe House Drainage without Ventilation." On the motion of Dr. Duncan, the discussion of these papers was deferred to a Special Meeting to be called by the Council.

13th March, 1889.

A Special Meeting of the Society was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 13th March, at eight o'clock p.m., for the purpose of taking discussions on the papers read by Mr. Hoey and Mr. Honeyman at the Ordinary Meeting on 6th inst.—Dr. J. B. Russell, President, in the Chair.

1. The Chairman stated that it had been arranged that Mr. Hoey should give a short summary of his paper, occupying about ten minutes, for the purpose of opening the discussion. That gentleman proceeded to do as requested.

2. At the Chairman's request, the Secretary then briefly stated how he had tested the state of the Ventilation in the Smoking Room of the Liberal Club in presence of a number of the members.

3. The following gentlemen afterwards joined in the discussion:—Mr. W. P. Buchan, Dr. Eben. Duncan, Mr. J. D. F. Andrews, Dr. Glaister, Mr. Key, Mr. David Thomson, and Mr. Jas. Chalmers, architects; and Mr. W. R. W. Smith. Mr. Hoey briefly replied.

4. Mr. Honeyman made a short statement by way of initiating the discussion on his paper; and the subsequent speakers were—Mr. W. R. W. Smith, Mr. Gilbert Thomson, C.E.; Mr. Key, Mr. Buchan, Mr Jas. Chalmers, Drs. Duncan and Glaister, Mr. W. Milne, and the Chairman, on whose motion a vote of thanks was passed to the authors of both papers. Mr. Honeyman briefly replied, and the proceedings terminated.

20th March, 1889.

The Ninth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 20th March, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Eighth Ordinary Meeting, held on 6th March, and of the Special Meeting, held on 13th March, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Mr. D. M. Nelson read a paper on a "Proposed Scheme for the Collection, Treatment, and Disposal of the Sewage of Glasgow." In the discussion which followed, remarks were made by the Chairman, Mr. Gilbert Thomson, C.E.; Mr. Frew, C.E.; Mr. White (Assistant Master of Works), Councillor Mechan, and Mr. W. R. W. Smith. A vote of thanks was passed to Mr. Nelson, who briefly replied to the various speakers.

3. Mr. J. D. F. Andrews read a paper on "Electric Light Wiring of Buildings." Mr. M'Whirter and Mr. H. A. Mavor made some remarks on the subject of the paper. On the motion of the Chairman, a vote of thanks was awarded to Mr. Andrews, who replied to the criticisms made by Mr. M'Whirter.

3rd April, 1889.

The Tenth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 3rd April, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Ninth Ordinary Meeting, held on 20th March, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Dr. Neil Carmichael exhibited and made remarks on Microphotographs of some Microbes [*Micrococcus Scarlatinæ (?)*] associated with the Garnethill Scarlet Fever Epidemic.

Lime-light views of the same were shown by the Photographic Society's new Lantern. A discussion took place, in which the speakers were—the President, Professor M'Kendrick, Dr. Glaister, Mr. James Thomson, and Dr. Morton. A cordial vote of thanks was passed to Dr. Carmichael, who briefly replied.

3. Dr. James Finlayson submitted a proposal for securing Uniformity of Action in the Exclusion from Day Schools of Children coming from Families affected with Contagious Diseases. Remarks were made on the subject of the paper by the President, who moved a vote of thanks to Dr. Finlayson; and by Dr. Glaister, Mr. Donald (Dennistoun Public School), Mr. Wilson (St. George's Road Public School), Mr. Fyfe, Sanitary Inspector, and Dr. M'Kendrick. After a brief reply by the author of the

paper, the President promised to bring his suggestions before the Council of the Society.

4. On the motion of the Secretary, the Society's thanks were voted to the Council of the Glasgow Photographic Association for the use of their Lantern, and to Mr. Armstrong for his services as manipulator.

10th April, 1889.

The Eleventh Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Natural Philosophy Class-Room of the University, Gilmorehill, on Wednesday, 10th April, 1889, at eight o'clock p.m.—Dr. J. B. Russell, President, in the Chair.

1. The Minutes of the Tenth Ordinary Meeting, held on 3rd April, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Sir William Thomson, F.R.S., showed some Gyrostatic Experiments, and gave explanations of the same, for which he was awarded the best thanks of the Society.

3. Mr. James T. Bottomley, F.R.S., communicated a Note on the Insulating Properties of some specimens of Glass; and he likewise exhibited two Leyden Jars which had been fractured by the Electric Spark. Mr. Bottomley received the thanks of the Society for his two communications

4. The President announced the decease of two Honorary Members of the Society—M. Michael Eugene Chevreul, Paris (elected 1860), and Professor Donders, Utrecht (elected 1887).

1st May, 1889.

The Twelfth Ordinary Meeting of the Philosophical Society of Glasgow, for Session 1888-89, was held in the Rooms of the Society, 207 Bath Street, on Wednesday, 1st May, 1889, at eight o'clock p.m.—Dr. J. G. M'Kendrick, Vice-President, in the Chair.

1. The Minutes of the Eleventh Ordinary Meeting, held on 10th April, which were printed in the Billet calling the Meeting, were held as read, were approved of, and signed by the Chairman.

2. Dr. J. Kerr Love read a paper on "The Acoustics of Musical Sounds," which he illustrated by his "Audiometer," a new instrument for testing the power of appreciating Musical Intervals. The thanks of the Society were awarded to Dr. Love for his paper, and in the discussion which followed, the Chairman, Mr. Julius Seligmann, Mr. W. M. Miller, Mr. Machell, Mr. Burt, and Mr. Johnston took part. Dr. Love briefly replied.

3. Mr. J. G. Kerr, M.A., read a biographical notice of the late Mr. E. M. Dixon, of Allan Glen's School, which he had prepared at the special request of the Council, and for which he received the thanks of the Society.

4. Reports from the various Sections of the Society were submitted and held as read, as was also Dr. Muirhead's Report as Delegate to the British Association Union of Corresponding Societies. These Reports were ordered for insertion in Vol. XX. of the Society's *Proceedings.*

The Society then adjourned for the Summer recess.

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* *Retire by rotation in November, 1889.*

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(See p. 333.)

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Annals of the Cape Observatory. Vol. 2, part 2,	,,
On the Variations of the Instrumental Adjustments on the Cape Transit Circle, . . .	,,
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BOOKS BOUGHT.

Dictionary of National Biography. Parts 16, 17, 18, 19. 1888-89.

Œuvres de Lagrange. Vol. 12. 4to. Paris, 1888.

The Senses, Instincts, and Intelligence of Animals. By Sir John Lubbock. 8vo. London, 1888.

Compendium of Geography and Travel—North America, by J. V. Hayden; and Asia, by A. H. Kean. 8vo. London, 1888.

Reclus' Universal Geography—European, Asiatic, and African Sections. 12 vols. 8vo. London.

Encyclopædia Britannica. Vol. XXIV. and Index Volume. 4to. Edinburgh, 1888-89.

Life of Siemens. By Dr. W. Pole. 8vo. London, 1888.

The Economic Interpretation of History. 8vo. London, 1881.

Comparative Morphology and Biology of the Fungi, Mycetozoa, and Bacteria. By A. De Bary. 8vo. Oxford, 1887.

A Treatise on the Principles of Chemistry. By M. M. Pattison Muir. 8vo. Cambridge, 1884.

The Statesman's Year-Book, 1889.

Mathematical Papers of Arthur Cayley. Vol. 1. 4to. Cambridge, 1889.

Official Year-Book of Scientific and Learned Societies. 8vo. London, 1889.

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Chalmers, James, I.A., 101 St. Vincent street. 1884
115 Cherrie, James M., Clutha cottage, Tollcross. 1876
Christie, James, A.M., M.D., F.F.P.S.G., 2 Great Kelvin terrace, Bank street, Hillhead. 1876
Christie, John, Turkey-red Works, Alexandria, Dumbartonshire. 1868
Chrystal, W. J., F.I.C., F.C.S., Shawfield Works, Rutherglen. 1882
Church, W. R. M., C.A., 75 St. George's place. 1885
120 Clapperton, Charles, 16 Lilybank gardens, Hillhead. 1882
Clapperton, John, 5 Sandyford pl. 1874
*Clark, G. W., Dumbreck house. 1877
Clark, Henry E., F.F.P.S., M.R.C.S. Eng., 24 India street. 1876
Clark, John, Ph.D., F.I.C., F.C.S., 138 Bath street. 1870
125 Clark, John, 9 Wilton crescent. 1872
*Clark, William, 125 Buchanan st. 1876
Clavering, Thos., 27 St. Vincent place. 1856
*Cleland, John, M.D., LL.D., D.Sc., F.R.S., Professor of Anatomy in the University of Glasgow. 1884
Clinkskill, James, 1 Holland place. 1868
130 Coats, Joseph, M.D., 31 Lynedoch street. 1873
*Cochran, Robert, 7 Crown circus, Dowanhill. 1877
Coghill, Wm. C., 263 Argyle street. 1873
Collins, Sir William, F.R.G.S., 3 Park terrace, East. 1869
Colquhoun, Jas., 158 St. Vincent st. 1876
135 Colville, James, M.A., D.Sc., 15 Newton place. 1885
Combe, William, 257 W. Campbell street. 1877
Connal, Sir Michael, Virginia buildings. 1848
Connell, James, 182 Crookston st. 1870
Connell, Wm., 38 St. Enoch square. 1870
140 Cooke, Stephen, F.C.S., 85 Buccleuch street. 1886
Copeland, Jas., Dundonald road, Kelvinside. 1869
Copland, Wm. R., M. Inst. C.E., 146 West Regent street. 1876
Coste, Jules, French Consulate, 131 West George street. 1888
Coubrough, A. Sykes, Blanefield, Strathblane. 1869
145 Coulson, Arthur, 56 George square. 1888
Couper, James, Craigforth House, Stirling. 1862
Cowan, David, Mount Gerald, Larbert. 1888
Cowan, M'Taggart, C.E., 27 Ashton terrace, Hillhead. 1876
Craig, Alexander T., 264 St. Vincent street. 1884
150 Craig, T. A., C.A., 139 St. Vincent street. 1886
Crawford, David, jun., Glengowan Print-works, Caldercruix, by Airdrie. 1873
Crawford, Robert, 84 Miller st. 1886
Crawford, W. B., 104 W. Regent st. 1872
Crawford, Wm. C., M.A., Lockharton gardens, Slateford, Edinburgh. 1869
155 Cree, Thomas S., 21 Exchange sq. 1869
Cross, Alexander, 14 Woodlands terrace. 1887
Cruikshank, George M., 62 St. Vincent street. 1885
Cumming, Thos., Angus Lodge, Hamilton. 1888
Cunningham, John M., 18 Woodside terrace. 1881
160 Cunningham, J. R., jun., 30 George square. 1881
Curphey, Wm. Salvador, 2 Princes square, Strathbungo. 1883
Cuthbert, Alexander A., 14 Newton terrace. 1885
*Cuthbertson, Sir John N., 29 Bath street. 1850

Dansken, A. B., 179 West George street. 1877
165 *Dansken, John, I.M., 121 West Regent street. 1876
Darling, Geo. E., 178 St. Vincent street. 1870
Deas, Jas., C.E., 7 Crown gardens, Dowanhill. 1869
Dempster, John, Cambridge terrace, Albert Road, Pollokshields. 1875
Dennison, William, C.E., 175 Hope street. 1876
170 Dewar, Duncan, St. Fillans, West Coates, Cambuslang. 1877
*Dick, George Handasyde, 136 Buchanan street. 1887
Dittmar, W., LL.D., F.R.S., F.R.S.E., Professor of Chemistry, Anderson's College. 1875
*Dixon, A. Dow, 10 Montgomerie crescent, Kelvinside. 1873

Dobbie, A. B., M.A., University. 1885
175 Donald, John, Dennistoun Public School. 1872
Donald, William J. A., 27 St. Vincent place. 1877
Dougall, Franc Gibb, 167 Canning street. 1875
Dougall, John, M.D., C.M., F.F.P.S.G., Lecturer on Materia Medica, Royal Infirmary School of Medicine, 6 Belmar terrace, Pollokshields. 1876
Douglas, Campbell, I.A., F.R.I.B.A., 266 St. Vincent street. 1870
180 Downie, R. M., 51 Dundas street. 1883
Downie, Robert, jun., Carntyne Dye-works, Parkhead. 1872
Downie, Thomas, Hydepark Foundry. 1886
Drew, Alex., 175 West George street. 1869
Duncan, Eben., M.D., C.M., F.F.P.S.G., 4 Royal crescent, Crosshill. 1873
185 *Duncan, Walter, 9 Montgomerie crescent. 1881
Dunlop, E. D., 40 W. Nile street. 1883
*Dunlop, Nathaniel, 1 Montgomerie crescent, Great Western road. 1870
Dunn, Robert Hunter, 4 Belmont crescent. 1878
Dyer, Henry, M.A., C.E., 8 Highburgh terrace, Dowanhill. 1883

190 Eadie, Alexander, 280 Cathcart road. 1885
Easton, Walter, 125 Buchanan st. 1878
Easton, William J., 150 West Regent street. 1876
Edwards, John, Govanhaugh Dye-works. 1883
Edwards, Matthew, 209 Sauchiehall street. 1887
195 Elder, James, C.E., 204 St. Vincent street. 1881
Elgar, Francis, LL.D., Admiralty, London. 1884
*Ellis, T. Leonard, North British Iron-works, Coatbridge. 1888
Erskine, Jas., M.A., M.B., L.F.P.S., 6 Newton street. 1886
*Ewing, Wm., 7 Royal Bank place. 1883

200 Fairweather, Wallace, C.E., 62 St. Vincent street. 1880
Falconer, Patrick, 33 Hayburn crescent, Partick. 1876
Falconer, Thos., 50 Kelvingrove st. 1880
Farquhar, John, 13 Belhaven terrace. 1872
Fawsitt, Charles A., 4 Maule terrace, Partick. 1879
205 Fergus, Freeland, M.B., F.F.P.S.G., 3 Elmbank crescent. 1887
Fergus, Jas., 5 Burnbank gardens. 1880
*Ferguson, John, M.A., LL.D., Professor of Chemistry, University of Glasgow. 1869
Ferguson, Peter, 15 Bute gardens, Hillhead. 1866
Ferguson, Thomas, Westmuir st., Parkhead. 1883
210 Fergusson, Alex. A., 48 M'Alpine street. 1847
Fernau, Paul, 6 Broomhill Avenue, Partick. 1887
Fife, William, 52 Glassford street. 1880
Finlay, H. G., 16 Westbourne ter. 1888
Finlay, Joseph, Clairmont, Winton drive, Kelvinside. 1873
215 Finlay, Robert Gilchrist, jun., Holmfield, Dalmuir. 1881
Finlayson, James, M.D., 2 Woodside place. 1873
*Fleming, James, 136 Glebe street. 1880
*Fleming, William James, M.D., 155 Bath street. 1876
Foulis, William, C.E., 42 Virginia street. 1870
220 *Fowler, John, Kelvinbank terrace, Sandyford. 1880
Frame, James, Union Bank of Scotland, 113 King street, Tradeston. 1885
Fraser, Matthew P., 91 W. Regent street. 1887
Fraser, Robert, 2 Crown gardens, Dowanhill. 1885
Frazer, Daniel, 127 Buchanan st. 1853
225 Frew, Alex., C.E., 175 Hope street. 1876
Fullarton, J. H., M.A., B.Sc., Natural History Department, University. 1886
Fyfe, Peter, 1 Montrose street. 1886

Gairdner, Charles, LL.D., Broom, Newton-Mearns. 1884
*Gairdner, C. D., C.A., 115 St. Vincent street. 1886
230 Gairdner, W. T., M.D., LL.D., Professor of Practice of Medicine in the University of Glasgow, 225 St. Vincent street. 1863
Gale, Jas. M., C.E., Water Office, 23 Miller street. 1856
Galloway, T. Lindsay, C.E., 43 Mair street, Plantation. 1881
Galt, Alex., B.Sc., F.R.S.E., F.C.S., 41 Westbourne gardens. 1887
Gardner, Daniel, 36 Jamaica street. 1869
235 *Garroway, John, 694 Duke st 1875
Geddes, Wm., Battlefield, Langside. 1846
Gibb, Peter, 10 Granby terrace. 1883
Gillespie, Edward, Chapel Croft, Cambuslang. 1882

Gillies, W. D., 2 Royal Exchange court. 1872
240 Gilfillan, Wm., 129 St. Vincent st. 1881
Glaister, John, M.B., 4 Grafton place. 1879
Goldie, James, 40 St. Enoch square. 1883
Goodwin, Robert, 58 Renfield st. 1875
Gourlay, John, C.A., 24 George sq. 1874
245 Gourlay, Robert, Kirklee avenue, Great Western road. 1869
Gow, Leonard, jun., 19 Waterloo street. 1884
Gow, Robert, Cairndowan, Dowanhill gardens. 1860
Graham, Alex. M., 20 Dixon street. 1887
Graham, David, jun., 140 Douglas street. 1876
250 Graham, Robert, 61 Eglinton street. 1888
*Graham, William, 195 Bath street. 1885
Grant, Robt., M.A., LL.D., F.R.S., Professor of Astronomy in the University of Glasgow, Observatory, *Hon. Vice-President.* 1860
Gray, James, M.D., 15 Newton terrace. 1863
Gray, James, 2 Balmoral crescent, Crosshill. 1876
255 Gray, Thomas, B.Sc., F.R.S.E., Physical Laboratory, University, 1887
Greenlees, Alex., M.D., 33 Elmbank street. 1864
Grierson, James, 5 Belhaven cres., Kelvinside. 1880
Grieve, John, M.A., M.D., F.R.S.E., care of W. L. Buchanan, 212 St. Vincent st. 1856
Griffiths, Azariah, Elmbank, Falkirk. 1886

260 Haldane, T. Fred., Cartvale Chemical Works, Paisley. 1884
Hamilton, George, 149 St. Vincent street. 1871
Hamilton, John, I.A., 212 St. Vincent street. 1885
Hannay, Jas. B., F.R.S.E., F.C.S., 67 Great Clyde street. 1879
Hannay, Maxwell, 104 West George street. 1881
265 Hart, Arthur, 20 Woodlands terrace. 1883
*Harvie, John, Secretary, Clydesdale Bank, 30 St. Vincent place. 1880
Harvie, William, 8 Bothwell terrace, Hillhead. 1888
*Henderson, A. P., 10 Crown terrace, Dowanhill. 1880
Henderson, George G., B.Sc., M.A., F.I.C., F.C.S., Chemical Laboratory, University. 1883
270 *Henderson, John, jun., 4 Crown terrace, Dowanhill. 1879
Henderson, Robert, 27 Union st. 1885
Henderson, Thos., 47 Union street. 1855
Henderson, Wm., Ennerdale, Winton drive, Kelvinside. 1853
*Henderson, Wm., 4 Windsor terrace, West. 1873
275 Henry, R. W., 8 Belhaven cres. 1875
Heys, Zechariah J., South Arthurlie, Barrhead. 1870
Higginbotham, James S., Springfield court, Queen street. 1874
Higginbotham, Robert Ker, 10 Great Hamilton street. 1885
Higgins, Henry, jun., 252 West George street. 1878
280 Hodge, William, 27 Montgomery drive, Kelvinside. 1878
Hoey, David G., 8 Gordon street. 1869
Hogg, Robert, Inglisby villa, Nithsdale drive, Pollokshields. 1865
Holt, T. G., 25 Wellington street. 1875
Honeyman, John, F.R.I.B.A., 140 Bath street. 1870
285 Horne, R. R., C.E., 150 Hope street. 1876
Horton, William, Birchfield, Mount Florida. 1889
Howat, William, 37 Elliot street. 1885
Howatt, James, I.M., 146 Buchanan street. 1870
Howatt, William, I. M., 146 Buchanan street. 1870
290 Hunt, Edmund, 87 St. Vincent street. 1856
*Hunt, John, Milton of Campsie. 1881

*Jack, William, M.A., LL.D., Professor of Mathematics in the University of Glasgow. 1881
Jackson, William V., 237 Ingram st. 1888
Jamieson, Andrew, F.R.S.E., M.Inst.C.E., M.S.T.E., &c., 38 Bath street. 1881
295 Jebb, Richard C., M.A., LL.D, Oxford. 1888
Johnson, James Yate, C.E., 115 St. Vincent street. 1883
Johnstone, Jas., Coatbridge street, Port-Dundas. 1869

Kay, Wm. E., Printworks, Thornliebank. 1887
Kean, James, 32 Scotia street, Garnethill. 1888
300 Kennedy, Hugh, Redclyffe, Partick. 1876
Kennedy, John A., M.B., C.M., Ellangowan, Bearsden. 1888
Kennedy, William, St. Margaret's, Newark drive, Pollokshields. 1882
Ker, Charles, M.A., C.A., 115 St. Vincent street. 1885

*Ker, Wm., 1 Windsor ter., west. 1874
305 Kerr, Adam, 175 Trongate. 1887
Kerr, Charles James, Greenfaulds house, Cumbernauld. 1877
Kerr, James Hy., 13 Virginia st. 1872
Kerr, John G., M.A., 16 Grafton street. 1878
Key, William, Tradeston Gas-works. 1877
310 King, James, 57 Hamilton drive, Hillhead. 1848
King, Sir James, Bart., LL.D., of Levernholm, 115 Wellington st. 1855
Kirk, Alexander C., LL.D., 19 Athole gardens, Dowanhill. 1869
Kirk, Robert, M.D., Newton cottage, Partick. 1877
Kirkpatrick, Alexander B., 24 Berkeley terrace. 1885
315 Kirkpatrick, Andrew J., 179 West George street. 1869
Knox, Adam, 47 Crownpoint road. 1881
Knox, John, 129 West George street. 1870
Knox, John, 151 Renfrew street. 1883

Laidlaw, John, 56 Hope street. 1885
320 Laird, George H., 159 Greenhead street. 1882
Laird, John, Marchmont, Port-Glasgow. 1876
Laird, John, Royal Exchange Sale Rooms. 1879
Lamb, Thomas, 220 Parliamentary road. 1870
Lang, William, jun., F.C.S., Crosspark, Partick. 1865
325 Latta, James, 73 Mitchell street. 1869
Latta, John, 138 West George st. 1880
Lazenby, Rev. Albert, 50 Prince's square, Strathbungo. 1885
Leitch, Alexander, 60 Rosebank terrace, Grant street. 1886
Lester, William, 2 Doune terrace, N. Woodside. 1884
330 Lester, W. R., M.A., 2 Doune terrace, N. Woodside. 1884
*Lindsay, Archd. M., M.A., 87 West Regent street. 1872
Lindsay, Wm. G., 157 St. Vincent street. 1871
Lochore, John, 8 Bellahouston ter., Ibrox. 1886
*Long, John Jex, 11 Doune terrace, Kelvinside. 1862
335 Lothian, J. Alexander, M.D., L.R.C.S.E., 6 Newton terrace. 1872
Love, James Kerr, M.B., C.M., M.D., 4 Matilda place, Strathbungo. 1888
Low, James, 176 St. Vincent st. 1878

M'Andrew, John, 17 Park Circus place. 1843
M'Ara, Alex., 65 Morrison street. 1888
340 Macarthur, J. G., Rosemary Villa, Bowling. 1874
M'Call, Samuel, 16 Hillsborough square, Hillhead. 1882
*M'Clelland, Andrew Simpson, C.A., 4 Crown gardens, Dowanhill. 1884
M'Conville, John, M.D., 27 Newton place. 1870
M'Crae, John, 7 Kirklee gardens, Maryhill. 1876
345 M'Creath, James, M.E., 208 St. Vincent street. 1874
Macdonald, Arch. G., 8 Park circus. 1869
Macdonald, Thomas, 109 Bath st. 1869
M'Farlane, Graham Jas., Elderslie. 1882
M'Farlane, Walter, Printworks, Thornliebank. 1869
350 Macfarlane, Walter, 12 Lynedoch crescent. 1885
M'Farlane, Wm., Edina Lodge, Rutherglen. 1888
M'Gillivray, James P., 209 West Campbell street. 1883
*M'Gilvray, R. A., 129 West Regent street. 1880
M'Gregor, Duncan, F.R.G.S., 37 Clyde place. 1867
355 M'Gregor, James, 1 East India avenue, London, E.C. 1872
M'Grigor, Alexander B., LL.D., 172 St. Vincent street. 1857
M'Houl, David, Ph.D. Dalquhorn works, Renton. 1883
*M'Ilwraith, James, 4 Westbourne terrace, Kelvinside. 1872
M'Intyre, Wm., Marion Bank, Rutherglen. 1888
360 M'Ivor, R. W. Emerson, F.I.C., F.C.S., St. George's Club, Hanover square, London. 1886
Mackay, John Yule, M.D., 34 Elmbank crescent. 1885
Mackay, John, jun., 354 Sauchiehall street. 1869
*M'Kenzie, W. D., 43 Howard street. 1875
*M'Kenzie, W. J., 197 Dumbarton road. 1879
365 *M'Kendrick, John G., M.D., C.M., LL.D., F.R.S., F.R.S.E., F.R.C.P.E., Professor of Institutes of Medicine in the University of Glasgow, 45 Westbourne gardens, *Vice-President.* 1877
Mackinlay, David, 6 Great Western terrace, Hillhead. 1855
*Mackinlay, James Murray, 4 Westbourne gardens. 1886
Mackinlay, Wm., 4 Bothwell terrace, Hillhead. 1887
M'Kissack, John, 103 W. Regent st. 1881

370 Maclae, A. Crum, 147 St. Vincent street. 1884
MacLean, Walter, 2 Bothwell cir. 1887
*Maclay, David T., 169 W. George street. 1879
Maclean, A. H., 8 Hughenden terrace, Kelvinside. 1870
Maclean, Magnus, M.A., F.R.S.E., 21 Hayburn crescent, Partickhill. 1885
375 MacLehose, James J., M.A., 61 St. Vincent street. 1882
M'Lennan, James, 40 St. Andrew's street. 1888
Macouat, B. R., 37 Elliot street 1885
Macphail, Donald, M.D., Garturk cottage, Whifflet, Coatbridge. 1877
M'Pherson, George L., 26 Albert road, Crosshill. 1872
380 M'Vail, D. C., M.B., 3 St. James' terrace, Hillhead. 1873
M'Whirter, William, Faraday Electrical Works, Govan. 1889
Machell, Thomas, 39 Great Western road. 1886
Main, Robert B., Milverton, Dalziel Drive, Pollokshields. 1885
Mann, John, C.A., 188 St. Vincent street, *Treasurer*. 1856
385 Mann, John, jun., M.A., C.A., 188 St. Vincent street. 1885
Manwell, James, The Hut, 4 Albert road, Pollokshields. 1876
Marwick, Sir J. D., LL.D., F.R.S.E., Killermont House, Maryhill. 1878
Marks, Samuel, Jeanette villa, Tollcross. 1884
*Mason, Stephen, M.P., 24 Belhaven terrace. 1870
390 Mathieson, Thomas A., 3 Grosvenor terrace. 1869
Mavor, Henry A., 56 George square. 1887
Mavor, James, 243 St. Vincent street. 1885
Mayer, John, 11 Balmoral crescent, Crosshill, *Secretary*. 1860
Mechan, Arthur, 60 Elliot street. 1876
395 Mechan, Henry, 60 Elliot street. 1879
Mees, A. R., 136 W. Regent street. 1888
Menzies, Thos., Hutchesons' Grammar School, Crown street. 1859
*Menzies, Thos. J., M.A., B.Sc., F.C.S., Stranraer Academy, Stranraer. 1887
Michaelson, M., 21 Huntly gardens. 1878
400 Middleton, Robert T., 179 West George street. 1860
Millar, James, 158 Parliamentary road. 1870
Miller, A. Lindsay, 121 W. Regent street. 1878
*Miller, Arch. Russell, The Cairns, Cambuslang. 1884
Miller, David S., 8 Royal crescent, W. 1887
405*Miller, George, Winton drive, Kelvinside. 1881
Miller, G. J., Frankfield, Shettleston. 1888
Miller, John (Messrs. James Black & Co.), 23 Royal Exchange square. 1874
Miller, Richard, 54 St. Enoch square. 1885
*Miller, Thos. P., Cambuslang Dyeworks. 1864
410 Miller, W. M., 7 Mansfield place, West Regent street. 1867
Mills, Edmund J., D.Sc., F.R.S., 60 John street. 1875
Milne, William, M.A., B.Sc., F.R.S.E., High School. 1881
Mirrlees, James B., Redlands, Kelvinside. 1869
Mitchell, George A., 67 West Nile street. 1883
415 Mitchell, Jas. L., 10 Gt. Western terrace. 1878
Mitchell, Robert, 12 Wilson street, Hillhead. 1870
*Moffatt, Alexander, 47 Union st. 1874
Moir, Charles S., 92 Union street. 1884
Mollison, James, 23 Hayburn cres., Partick. 1889
420*Monteith, Robert, Greenbank, Dowanhill gardens. 1885
Moore, Alexander, C.A., 209 West George street. 1869
Moore, Alexander George, M.A., B.Sc., 13 Clairmont gardens. 1886
Morgan, John, Springfield house, Bishopbriggs. 1844
Morrice, Jas. A., 1 Athole gardens place. 1883
425 Morrison, James, 98 Sauchiehall street. 1869
Morton, James, M.D., Professor of Materia Medica in Anderson's College, 199 Bath street, *Vice-President*. 1868
Mossman, John, 6 Queen's terrace, West. 1870
Motion, James Russell, 38 Cochrane street. 1887
Muir, Alex., 400 Eglinton street. 1883
430*Muir, Allan, 36 George street. 1881
Muir, James, C.A., 149 West George street. 1887
Muir, John, 6 Park gardens. 1876
Muir, Thomas, M.A., LL.D., F.R.S.E., Beechcroft, Bothwell. 1874
*Muirhead, Andrew Erskine, Cart Forge, Crossmyloof. 1873

435 *Muirhead, Henry, M.D., LL.D., F.F.P.S.G., Bushy Hill, Cambuslang, *Hon. Vice-President.* 1866
Muirhead, James, 10 Doune gardens, Kelvinside. 1887
*Muirhead, Robert F., M.A., B.Sc., Abbotsholme, Rocester, Stafford. 1879
Munro, Daniel, 10 Doune terrace, Kelvinside. 1867
Munsie, George, 1 St. John's ter., Hillhead. 1871
440 Munsie, Robert George, 10 Berkeley terrace, West. 1883
Murdoch, Robert, 19 Commerce street. 1880
Murdoch, William, 79 Robertson street. 1879
*Murray, David, 169 West George street. 1876
Murray, A. Erskine, Sheriff-Substitute of Lanarkshire, Sundown, Montgomerie drive. 1881

445 Napier, Alex., M.D., F.F.P.S.G., 3 Royal terrace, Crosshill. 1886
Napier, James, jun., 15 Princes square, Strathbungo. 1870
*Napier, John, 23 Portman square, London. 1846
Nelson, Alex., 80 Gordon street. 1880
Nelson, D. M., 164 St. Vincent street. 1875
450 *Newlands, Joseph F., 28 Renfield street. 1883
Newman, David, M.D., C.M., Pathologist, Royal Infirmary, 18 Woodside place, W. 1877
Nicholson, Alex., jun., 6 Annfield place, Dennistoun. 1883
Nowery, William, 37 Derby street. 1876

Ogilvie, William, 1 Doune terrace. 1881
455 Osborne, Alex., 5 Oakley terrace, Dennistoun. 1870
Outram, D. E., 16 Grosvenor ter., Hillhead. 1878

Park, James, Millburn Chemical Works. 1877
*Parnie, James, 32 Lynedoch street. 1874
Paterson, John, 522 Pollokshaws road. 1888
460 *Paterson, Robert, C.A., 28 Renfield street. 1881
Paton, Jas., F.L.S., Corporation Galleries, and Kelvingrove Museum. 1876
Patterson, T. L., F.C.S., at John Walker & Co.'s, Greenock. 1873
Petrie, Alexander, I.A., 111 Bath street. 1885
Pirie, John, M.D., 26 Elmbank crescent. 1877
465 *Pirrie, Robert, 9 Buckingham ter. 1875
*Pollock, R., M.B., C.M., F.F.P.& S.G., Laurieston house, Pollokshields. 1883
Poynter, John E., 72 Great Clyde street. 1866
Price, Rees, L.D.S., Eng., 163 Bath street. 1883
Pride, David, M.D., Townhead House, Neilston. 1887
470 *Provan, James, 40 West Nile st. 1868
Provand, A. D., M.P., 8 Bridge street, London, S.W. 1888

Raalte, Jacques Van, 136 West Regent street. 1884
Ramsay, John, of Kildalton, 5 Dixon street. 1856
Ramsay, Robert, M.D., L.R.C.S.E., Lochwinnoch. 1881
475 Rankine, David, C.E., 75 West Nile street. 1875
Rankine, Captain John, 31 Airlie terrace, Pollokshields. 1869
Rattray, Rev. Alex., M.A., Parkhead parish, 4 Westercraigs, Dennistoun. 1879
Reid, Andrew, 20 North Albion st. 1875
Reid, David, 209 Sauchiehall street, 1887
480 *Reid, Hugh, 10 Woodside terrace. 1880
Reid, James, 10 Woodside terrace. 1870
Reid, J. G., 9 St. Vincent place. 1874
Reid, Thos., M.D., 11 Elmbank street. 1869
Reid, William, M.A., High School. 1881
485 *Reid, William L., M.D., 7 Royal crescent, West. 1882
Reith, Rev. George, M.A., Free College Church, 37 Lynedoch st. 1876
Rennie, John, 87 Park road. 1886
Renton, James Crawford, M.D., L.R.C.P.&S.Ed., 2 Buckingham terrace. 1875
Rey, Hector, B.L., B.Sc., 27 Kersland terrace. 1889
490 Richmond, Thos., L.R.C.P.E., 26 Burnbank terrace. 1887
Ritchie, R. Brown, 79 West Regent street. 1883
Robertson, Archibald, 25 Queen st. 1863
Robertson, Archibald, 12 Hope st. 1867
Robertson, Archibald, Ballancleroch, Lennoxtown. 1884
495 Robertson, Rev. James, D.D., Professor of Oriental Languages in the University of Glasgow. 1884
Robertson, John, 10 Valeview ter., Langside, *Librarian.* 1860
Robertson, J. M'Gregor, M.A., M.B., Muirhead Demonstrator of Physiology, University. 1881
Robertson, Robert, Coplawhill, Pollokshaws road. 1877

Robertson, Robert A., Nenthorne, 42 Aytoun road, Pollokshields. 1877
500 Robertson, Robert H., Clyde Bank, Rutherglen. 1888
Robertson, William, C.E., 123 St. Vincent street. 1869
Robson, Hazelton R., 14 Royal crescent, West. 1876
*Rogers, John C., 163 W. George st. 1888
Rose, Alexander, Richmond House, Dowanhill. 1879
505 Ross, David, M.A., B.Sc., LL.D., E.C. Training College. 1888
Ross, Henry, 7 Park quadrant. 1876
*Ross, John, 9 Westbourne gardens. 1885
Rottenburg, Paul, 21 St. Vincent pl. 1872
Rowan, David, 22 Woodside place. 1863
510 Rowan, W. G., 234 West George st. 1881
Rundell, R. Cooper, Underwriters' Room, Royal Exchange. 1877
Russell, James B., B.A., M.D., LL.D., 3 Foremount terrace, Partick, *President*. 1862

Salmon, W. Forrest, F.R.I.B.A., 197 St. Vincent street. 1870
Schmidt, Alfred, 492 New City road. 1881
515 Scott, Alex., 2 Lawrence place, Dowanhill. 1871
*Scott, D. M'Laren, Braidfaulds avenue, Tollcross. 1881
Scott, Robt., I.M., 115 Wellington street. 1884
Seligmann, Hermann L., 135 Buchanan street. 1850
Sheriff, John, 156 St. Vincent st. 1876
520 Sim, William, 3 Royal crescent. 1862
Simons, Michael, 206 Bath street. 1880
Simpson, P. A., M.A. Cantab., M.D., Regius Professor of Forensic Medicine, University, 1 Blythswood square. 1881
Sinclair, Alexander, Ajmere lodge, Langside. 1883
Sinclair, D., National Telephone Co., Limited, 8a Royal Exchange buildings. 1883
525 Smart, William, M.A., Nunholm, Dowanhill. 1886
Smellie, George, I.M., 167 St. Vincent street. 1880
*Smellie, Thos. D., 209 St. Vincent street. 1871
Smith, D. Johnstone, C.A., 149 W. George street. 1888
Smith, Francis, 45 Gordon street. 1875
530 Smith, Harry J., Ph.D., Coltness Iron-works, Newmains. 1877
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*Stephen, John, Domira, Partick. 1880
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*Steven, Hugh, Westmount, Montgomerie drive. 1869
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Thomson, Jonathan, 136 W. George street. 1869
Thomson, Sir William, LL.D., D.C.L., F.R.SS., L. & E., Professor of Natural Philosophy, University of Glasgow, *Hon. Vice-President*. 1846
580 Thomson, William, B.A., Linden, Bearsden. 1888
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*Tullis, James Thomson, Anchorage, Burnside, Rutherglen. 1883
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*Watson, Thomas Lennox, I.A., F.R.I.B.A., 108 W. Regent st. 1876
*Watson, William Henry, 10 Woodlands terrace. 1870
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605 Welsh, Thos. M., 51 St. Vincent crescent. 1883
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Woodburn, W. S., L.D.S., Lecturer on Mechanical Dentistry, Anderson's College, 17 Carlton place. 1881
630 Wyper, James, 6 Burnbank gardens. 1878

Yellowlees, D., M.D., Medical Superintendent, Gartnavel. 1881
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Young, John, 234 Parliamentary road. 1881

635*Young, John, jun., M.A., B.Sc., Dunard, Busby. 1887

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*Young, Thos. Graham, Westfield, West Calder. 1880

Younger, George, 166 Ingram street. 1847

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THE PHILOSOPHICAL SOCIETY OF GLASGOW.

INVENTORY of all Property (except the Library) possessed by the Society—made by the Treasurer in compliance with Article XI. of the Articles of Association, and presented to the Annual Meeting on 21st November, 1888.

I.—ITEMS, THE EXCLUSIVE PROPERTY OF THE SOCIETY.

All as detailed in the following Annual Inventories duly presented, viz.:—

Of 1884, printed in the *Proceedings* for			1884-85, Vol.	XVI.,	pp. 405-6.
Of 1885,	do.	do.	1885-86, Vol.	XVII.,	p. 466.
Of 1886,	do.	do.	1886-87, Vol.	XVIII.,	p. 458.
Of 1887,	do.	do.	1887-88, Vol.	XIX.,	p. 440.

In 1888 no additions were made.

II.—ITEMS, THE PROPERTY OF THE SOCIETY JOINTLY WITH THE "INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND."

All as detailed in the following Annual Inventories duly presented, viz.:—

Of 1884, printed in the *Proceedings* for			1884-85, Vol.	XVI.,	pp. 406-7.
Of 1885,	do.	do.	1885-86, Vol.	XVII.,	p. 466.
Of 1886,	do.	do.	1886-87, Vol.	XVIII.,	p. 458.

In 1887 no additions were made.

In 1888 the following additions were made:—

IN LIBRARY.

Extra Shelves throughout Bookcases, A to Z, costing 14s.

Dating Stamp "Received," and Fittings, costing 29s.

IN NORTH ROOM, LOWER FLAT.

Extra Bookcase fitted, for "Institution of Engineers" Books, costing £13 3s.

JNO. MANN, *Treasurer.*

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PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY

OF GLASGOW.

1888-89.

VOL. XX.

EDITED BY THE SECRETARY.

PUBLISHED FOR THE SOCIETY BY

JOHN SMITH AND SON,

129 WEST GEORGE STREET, GLASGOW.

1889.

R. ANDERSON,] [PRINTER.

Price—Ten Shillings and Sixpence.

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TO THE

PROCEEDINGS

OF THE

PHILOSOPHICAL SOCIETY OF GLASGOW.

VOLS. I. TO XX.—1841-89.

GLASGOW:
Printed at the University Press by
ROBERT MACLEHOSE, 153 WEST NILE STREET.
1892.

PREFACE.

On the 9th of November, 1802, a meeting called by circular was held in the Prince of Wales Tavern, Glasgow, to consider the advisability of establishing a society for the discussion of subjects bearing upon the trade and manufactures of the country, and the improvement of the Arts and Sciences. At this meeting a committee was appointed to draw up a constitution for a society, to be called "The Glasgow Philosophical Society." At a second meeting held on the 16th of the same month, the committee made a report which was adopted. The first election of office-bearers took place on the 29th of December, 1802.

The old book containing the Minutes of the Society from 1802 till 1846 is still in the possession of the Society. No Transactions or Proceedings were printed prior to 1841, but papers considered worthy of preservation were copied at the expense of the Society into books kept for the purpose. Unfortunately no trace of these books can now be found.

The early papers were of a very practical nature, and the short summaries given in the Minutes are extremely interesting, more especially in the light of the advance that has since been made in the Arts and Sciences, and in the improvement of the River Clyde and the City of Glasgow.

The publication of the Proceedings of the Society was begun during Session 1841-42, and since then they have been issued without interruption. The 20th volume contains the Proceedings of Session 1888-89. Being convinced of the advantage of rendering the information contained in the Proceedings more accessible to the members, the Council authorised the publication of an Index to the first twenty volumes. In the preparation of this Index I have to acknowledge the assistance given by Dr. Mills, of Anderson's College; Professor Ferguson, of Glasgow University; and the Sub-Librarian, Mr. Martin.

To add to the interest and value of the volume, a list of the different places in which the Society held its meetings from 1802 till 1889, and the names of the office-bearers of the Society during these 88 years, were collected from the Minute Books, and have been prefixed. In this part of the work I had the assistance of Mr. John Mann.

Some interesting information with regard to the early years of the Society will be found in Volumes I. and XVIII.

JOHN ROBERTSON, *Librarian*,
Convener of the Library Committee.

1st May, 1892.

PROCEEDINGS OF THE PHILOSOPHICAL SOCIETY OF GLASGOW. FIRST TWENTY VOLUMES—FROM 1841 TO 1889—WITH THE SESSIONS TO WHICH THEY REFER.

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PLACES OF MEETING OF THE PHILOSOPHICAL SOCIETY OF GLASGOW, FROM 1802 TO 1889.

Nov. 1802-Nov. 1803—Prince of Wales Tavern which was then at 33 Brunswick Street.

Nov. 1803-May 1806—Assembly Room Buildings, Ingram Street, lately the Athenæum and now (1892) part of the General Post Office.

May 1806-May 1812—Surgeons' Hall Buildings, in the centre of the east side of St. Enoch's Square, where the Railway Station now stands.

May 1812-Jan. 1816—Smith's Court, at 53 Candleriggs.

Jan. 1816-May 1819—At that time 35 (top of) Virginia Street.

May 1819-May 1820—South side of Trongate, opposite Hutcheson Street.

May 1820-Feb. 1832—Annuity Hall, Pratt's Court, entering from Argyle Street, and Maxwell Street.

Feb. 1832-Nov. 1868—Andersonian University, now Anderson's College, George Street.

Nov. 1868-Nov. 1880—Corporation Buildings, Sauchiehall Street.

Nov. 1880 and onwards—The Buildings erected jointly by the Philosophical Society and the Institute of Engineers and Shipbuilders, 207 Bath Street.

Office-Bearers of the Philosophical Society of Glasgow from 1802 till Nov., 1880.

YEARS. Commencing 1st Nov.	PRESIDENTS.	VICE-PRESIDENTS.	SECRETARIES.	TREASURERS.	LIBRARIANS.
1802-03	Dr. William Meikleham,	John Robertson,	James Laird,	John Lindsay,	Office not created
1803-04	Do.,	Do.,	William Duncan,	Do.,	
1804-05	John Geddes,	Robert Hastie,	James Bone,	James Cullen,	
1805-06	Do.,	Do.,	Do.,	Alexr. Drummond,	
1806-07	George M'Intosh,	Dr. James Watt,	Do.,	Do.,	
1807-08	Dr. James Monteath,	Do.,	Do.,	Robert Hastie,	
1808-09	Dr. James Watt,	James Fleming,	Do.,	Do.,	
1809-10	Richard Gillespie,	Do.,	Do.,	John Lindsay,	
1810-11	Do.,	Do.,	Do.,	Do.,	
1811-12	James Denholm,	Dr. James Watt,	Do.,	James Cook,	William Freeland.
1812-13	Do.,	Do.,	Do.,	Do.,	William Duncan.
1813-14	Do.,	Do.,	Do.,	John Lindsay,	Do.
1814-15	Do.,	James Fleming,	Do.,	William Duncan,	Do.
1815-16	James Fleming,	Robert Hastie,	Do.,	Thomas Muir,	John M'Causland.
1816-17	Dr. Robert Watt,	Dr. James Watt,	Do.,	Do.,	Do.
1817-18	John Geddes,	Do.,	Do.,	Do.,	Do.
1818-19	Do.,	Do.,	Do.,	Do.,	Do.
1819-20	Do.,	Dr. John Nimmo,	Do.,	James Lumsden, Jun.,	Do.
1820-21	Robert Hastie,	Do.,	Do.,	Do.,	R. Wallace.
1821-22	Do.,	Do.,	Do.,	Do.,	Do.
1822-23	Do.,	Alexander Watt,	Do.,	Do.,	Robt. Buchanan.
1823-24	Do.,	John Hart,	Do.,	Do.,	Robert Hart.
1824-25	Do.,	Do.,	Do.,	Do.,	Do.
1825-26	Do.,	Do.,	Do.,	Do.,	Do.
1826-27	Do.,	Alexander Watt,	Do.,	Do.,	Do.
1827-28	Andrew Liddell,	John Hart,	Do.,	Nicol Handyside,	Do.
1828-29	Do.,	Do.,	Do.,	John Eadie,	Do.
1829-30	Do.,	Do.,	Do.,	Do.,	Do
1830-31	Do.,	Do.,	John Eadie,	John Smith,	Do.
1831-32	Do.,	Do.,	Do.,	Do.,	Do.
1832-33	Do.,	John Thomson,	Do.,	George Smith,	James Smith.
1833-34	Do.,	Prof. Thomas Graham,	Alexander Hastie,	Do.,	Do.
1834-35	Dr. Thomas Thomson,	Do.,	Do.,	Andrew Liddell,	Do.
1835-36	Do.,	Do.,	Do.,	Do.,	Do.
1836-37	Do.,	Do.,	Do.,	Do.,	Do.
1837-38	Do.,	Walter Crum,	Do.,	Do.,	Do.
1838-39	Do.,	Do.,	Do.,	Do.,	Do.
1839-40	Do.,	Do.,	Do.,	Do.,	John James Griffin.
1840-41	Do.,	Do.,	Do.,	Do.,	Do.

1841-42	Do.,	Do.,	Do.,	Do.,	Do.
1842-43	Do.,	Do.,	Do.,	Do.,	Thomas Dawson.
1843-44	Do.,	Do.,	Do.,	Do.,	Do.
1844-45	Do.,	Do.,	Do.,	Do.,	Do.
1845-46	Do.,	Do.,	Do.,	Do.,	John James Griffin.
1846-47	Do.,	Do.,	Do.,	Do.,	Do.
1847-48	Do.,	Do.,	Alex. Hastie and Wm. Keddie,	Do.,	Dr. R. D. Thomson.
1848-49	Do.,	Do.,	Do.,	Do.,	Do.
1849-50	Do.,	Do.,	Do.,	Do.,	Do.
1850-51	Do.,	Do.,	Do.,	Do.,	Do.
1851-52	Do.,	Do.,	Do.,	Do.,	Do.
1852-53	Walter Crum,	Dr. George A. Walker Arnott and Dr. Allen Thomson,	Do.,	Do.,	William Cockey.
1853-54	Do.,	Dr. Allen Thomson and Wm. Gourlie,	Do.,	Do.,	Do.
1854-55	Dr. Allen Thomson,	Wm. Gourlie and Alex. Harvey,	Do.,	William Cockey,	Do.
1855-56	Do.,	Alexander Harvey and W. J. Macquorn Rankine,	Do.,	Do.,	William Gourlie.
1856-57	Prof. William Thomson,	W. J. Macquorn Rankine and James Bryce, jun.,	Do.,	Do.,	Dr. Thomas Anderson
1857-58	Do.,	James Bryce and Robert Hart,	Do.,	Do.,	Do.
1858-59	Prof. Thomas Anderson,	W. J. Macquorn Rankine and Robert Hart,	Do.,	Do.,	Dr. James Bryce.
1859-60	Do.,	W. J. Macquorn Rankine and Alex. Harvey,	Do.,	Do.,	Do.
1860-61	Prof. W. J. Macquorn Rankine,	Henry D. Rogers and Alex. Harvey,	Do.,	Do.,	Do.
1861-62	Do.,	Henry D. Rogers and Robert Hart,	Do.,	Do.,	Do.
1862-63	Prof. Henry D. Rogers,	Prof. Wm. Thomson and Robert Hart,	Do.,	Do.,	Do.
1863-64	Do.,	Prof. Robert Hart and Prof. Wm. Thomson,	Do.,	Do.,	Do.
1864-65	Do.,	Prof. Allen Thomson and Dr. Francis H. Thomson,	William Keddie,	James Reid,	Do.
1865-66	Dr. Francis Hay Thomson,	Prof. Allen Thomson and Dr. James Bryce,	Do.,	Do.,	Rev. H. W. Crosskey.
1866-67	Do.,	Dr. James Bryce and Prof. Robert Grant,	Do.,	John Mann,	Do.
1867-68	Do.,	Dr. James Bryce and Prof. Robert Grant,	Do.,	Do.,	Do.
1868-69	Dr. James Bryce,	Prof. Robert Grant and Prof. Allen Thomson,	Do.,	Do.,	Do.
1869-70	Do.,	Prof. Allen Thomson and Dr. Francis H. Thomson,	Do.,	Do.,	St. John Vincent Day.
1870-71	Do.,	Prof. Allen Thomson and Sir William Thomson,	Do.,	Do.,	Do.
1871-72	Prof. Robert Grant,	Prof. Sir Wm. Thomson and Prof. John Young,	Do.,	Do.,	Do.
1872-73	Do.,	Prof. Sir Wm. Thomson and Prof. John Young,	Do.,	Do.,	Do.
1873-74	Do.,	Prof. John Young and Prof. Allen Thomson,	Do.,	Do.,	Do.
1874-75	Prof. Sir Wm. Thomson,	Prof. Allen Thomson and Dr. Andrew Fergus,	Do.,	Do.,	Do.
1875-76	Do.,	Prof. Allen Thomson, Dr. A. Fergus, and Jas. R. Napier,	Do.,	Do.,	Edward M. Dixon.
1876-77	Do.,	Dr. Andw. Fergus, Jas. R. Napier, and Dr. Wm. Wallace,	Do.,	Do.,	John Robertson.
1877-78	Dr. Andrew Fergus,	Jas. R. Napier, Dr. Wm. Wallace, and Dr. And. Buchanan,	Edward M. Dixon,	Do.,	Do.
1878-79	Do.,	Dr. Wm. Wallace, Dr. A. Buchanan, and Dr. H. Muirhead,	Do.,	Do.,	Do.
1879-80	Do.,	Dr. And. Buchanan, Dr. H. Muirhead, and Thomas Muir,	Do.,	Do.,	Do.
1880-81	Dr. William Wallace,	Dr. Henry Muirhead, Thos. Muir, and Michael Connal,	Dr. J. G. M'Kendrick,	Do.,	Do.
1881-82	Do.,	Thomas Muir, Michael Connal, and James Mactear,	Do.,	Do.,	Do.
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1884-85	Do.,	Dr. J. B. Russell, Alex. Scott, and Dr. W. G. Blackie,	Do.,	Do.,	Do.
1885-86	Do.,	Alexander Scott, Dr. W. G. Blackie, and Dr. Morton,	Do.,	Do.,	Do.
1886-87	Dr. James B. Russell,	Dr. W. G. Blackie, Dr. Morton, and J. J. Coleman,	John Mayer,	Do.,	Do.
1887-88	Do.,	Dr. Morton, J. J. Coleman, and Prof. J. G. M'Kendrick,	Do.,	Do.,	Do.
1888-89	Do.,	J. J. Coleman, Dr. J. G. M'Kendrick, and W. R. Watson,	Do.,	Do.,	Do.

PHILOSOPHICAL SOCIETY OF GLASGOW.

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The Names of Authors are printed in CAPITALS.

The Subjects of Papers are printed in **Black Letter.**

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